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Spotting developments in UWB technology

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Configure optimal RF switching systems

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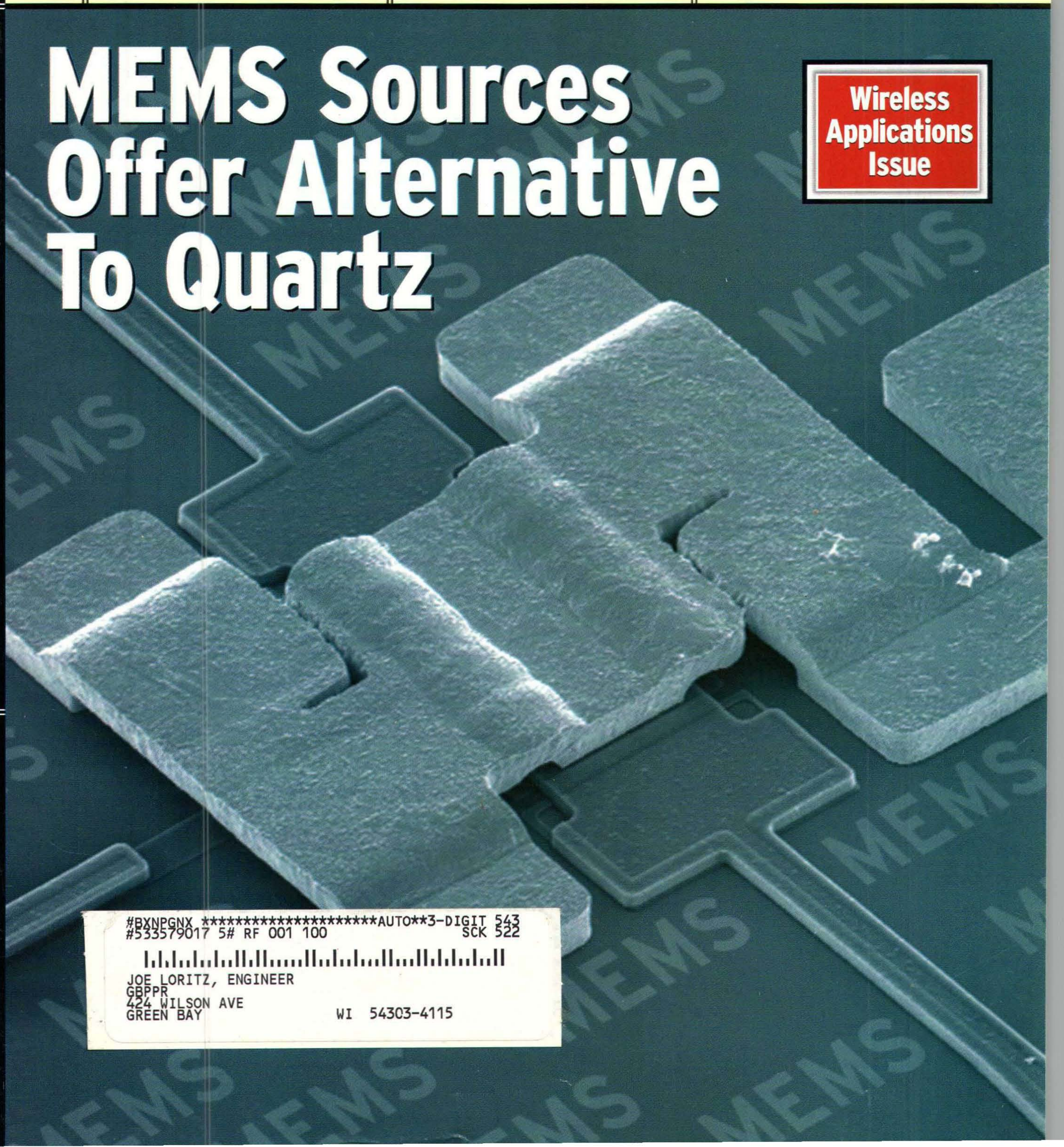
MEMS Sources Offer Alternative To Quartz

Wireless Applications Issue



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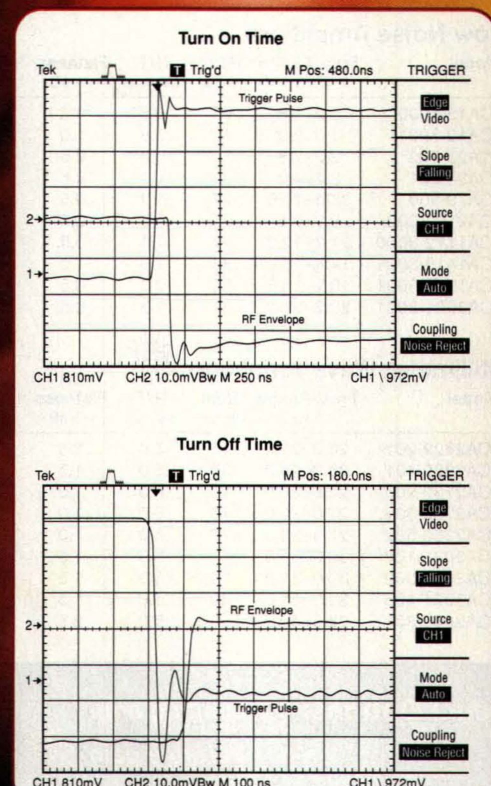

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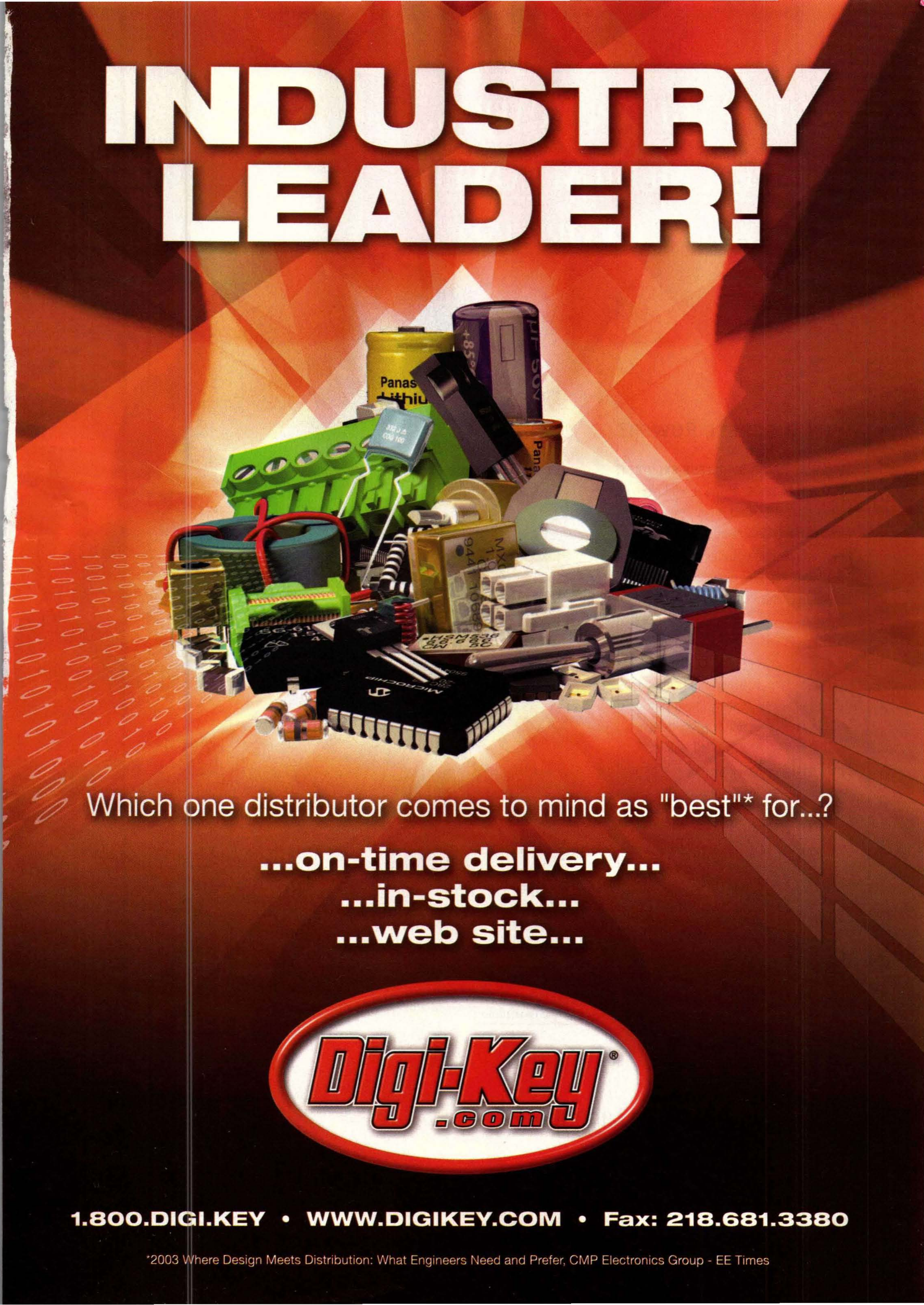
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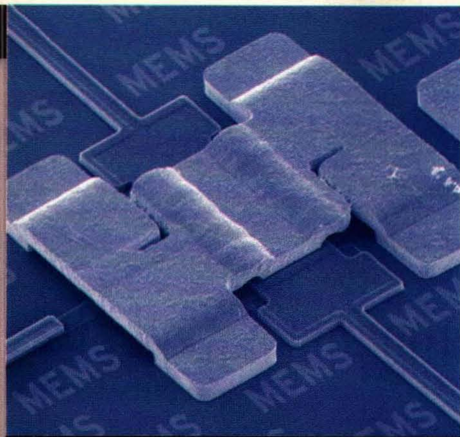

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Fixed Attenuators, dc-40 GHz, 5-1,000 Watts

Model Number	Average Power (Watts)	Peak Power (kW)	Frequency Range (GHz)	Nominal Attenuation Value (dB)	SWR	Connector Type
◆ 23	10	1	dc-18.0	3, 6, 10, 20, 30, 40, 50, 60	1.15-1.35*	N
◆ 24	50	5	dc-8.5	3, 6, 10, 20, 30	1.20-1.30*	N, 2.92mm
◆ 33	25	5	dc-8.5	3, 6, 10, 20, 30, 40	1.20-1.30*	N, 2.92mm
◆ 34	25	5	dc-4.0	3, 6, 10, 20, 30	1.10-1.20*	N
◆ 37	10	1	dc-8.5	3, 6, 10, 20, 30	1.15-1.25*	N
◆ 40	150	10	dc-1.5	3, 6, 10, 20, 30, 40	1.10	N
◆ 41	10	1	dc-18.0	1, 2, 3, 6, 10, 20, 30	1.20-1.35*	SMA
◆ 45	250	10	dc-1.5	3, 6, 10, 20, 30, 40	1.10	N
◆ 46	25	1	dc-18.0	3, 6, 10, 20, 30, 40	1.20-1.35*	N, 3.5mm
◆ 47	50	1	dc-18.0	3, 6, 10, 20, 30, 40	1.20-1.45*	N, 3.5mm
◆ 48	100	1	dc-18.0	10, 20, 30, 40	1.25-1.45*	N, 3.5mm
◆ 49	150	5	dc-8.5	3, 6, 10, 20, 30, 40	1.25-1.35*	N
53	500	10	dc-2.5	3, 6, 10, 20, 30, 40	1.10	N
◆ 57	150	10	dc-5.0	6, 10, 20, 30, 40	1.20	N
◆ 58	250	10	dc-5.0	6, 10, 20, 30, 40	1.15-1.20*	N
59	100	10	dc-2.5	10, 20, 30, 40	1.15	N
65	150	10	dc-2.5	3, 6, 10, 20, 30	1.20	N
66	150	1	dc-18.0	10, 20, 30, 40	1.60	N
67	350	5	dc-12.7	10	1.30-1.60*	N
68	100	10	dc-4.0	1,2, 3, 6, 10, 20, 30	1.20-1.25	N
◆ 69	5	0.5	dc-18.0	1-10, 20, 30	1.15-1.35*	SMA
72	50	5	dc-4.0	3, 6, 10, 20, 30	1.20	N
73	100	5	dc-8.5	3, 6, 10, 20, 30, 40	1.25-1.35*	N
74	25	0.5	dc-26.5	3, 6, 10, 20, 30	1.25-1.30*	3.5mm
75A	5	0.2	dc-40.0	10, 20, 30	1.20-1.35*	2.92mm
77	25	5	dc-5.0	3, 6, 10, 20, 30	1.20-1.30*	7/16
78	50	5	dc-5.0	3, 6, 10, 20, 30	1.20-1.30*	7/16
79	150	10	dc-5.0	3, 6, 10, 20, 30	1.20-1.35*	7/16
82	1,000	10	dc-3.0	20, 30, 40	1.15-1.25*	N, 7/16
❖ 89	20	2	dc-40.0	10, 20, 30	1.25-1.40*	2.92mm
❖ 90	50	1	dc-18.0	3, 6, 10, 20, 30	1.15-1.30*	N

❖ NEW PRODUCT!

Terminations, dc-40 GHz, 5-1,000 Watts

Model Number	Average Power (Watts)	Peak Power (kW)	Frequency Range (GHz)	SWR	Connector Type
1418	10	1	dc-18.0	1.15-1.40*	N
◆1419	10	1	dc-18.0	1.20-1.35*	SMA
◆1424	5	5	dc-12.4	1.03-1.40*	BNC, N
1425	10	1	dc-12.4	1.03-1.40*	BNC, N
◆1426	50	5	dc-8.5	1.20-1.30*	N, 2.92mm
◆1427	25	5	dc-10.0	1.10-1.15*	N, 2.92mm
1428	150	10	dc-1.5	1.10	N
1435	150	10	dc-5.0	1.10-1.15*	N
1429	25	1	dc-18.0	1.20	N, 3.5mm
1430	50	1	dc-18.0	1.15-1.30*	N, 3.5mm
1431	100	1	dc-18.0	1.20-1.30*	N, 3.5mm
1432	150	5	dc-8.5	1.20-1.30*	N
1433	250	10	dc-5.0	1.10-1.15*	N
1434	500	10	dc-2.5	1.10	N
1439	150	10	dc-2.5	1.20	N
1440	100	10	dc-4.0	1.15	N
1441	50	5	dc-4.0	1.15	N
1442	100	10	dc-8.5	1.20-1.30*	N
1443	5	0.5	dc-18.0	1.20	SMA
1453	10	1	dc-8.5	1.15-1.25*	N
1445A	5	0.2	dc-40.0	1.20-1.35*	2.92mm
1446	25	5	dc-5.0	1.20	7/16
1447	50	5	dc-5.0	1.20	7/16
1448	150	10	dc-5.0	1.25	7/16
1452	25	2.5	dc-4.0	1.10-1.20*	N
1453	10	1	dc-8.5	1.15-1.25*	N
1456	1,000	10	dc-3.0	1.15-1.25*	N

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Missing Transistors

THIS REQUEST is to find out why we were not covered in your recent article on power transistors, "Tracking Advances In Solid-State Power" (July, p. 33).

John Titizian
President
Integra Technologies, Inc.
321 Coral Circle
El Segundo, CA 90245-4620
(310) 606-0855

Editor's Note: Although we pride ourselves on the completeness of our research efforts, unfortunately at times some important suppliers are overlooked during the preparation of a product survey article such as the report on high-power transistors in July. The omission of Integra Technologies (El Segundo, CA) from that July story is made even more embarrassing by the fact that the company has been an advertiser in this magazine as recently as 2002, and we should have known better!

Inevitably, a company or two may be overlooked in compiling data, in this case a large amount of specifications on high-power transistors. Our apologies to John and the folks at Integra Technologies for not having included them, with the promise of making sure that they will be featured in the next such report.

In the meantime, a quick look at the company's website at www.integratech.com reveals an impressive lineup of silicon bipolars, high-power DMOS devices, S-band radar transistors, LDMOS devices, and even GaAs MESFETs. For example, the company's model IB1011S800ML is a high-power bipolar transistor designed for avionics applications at 1030/1090 MHz. The pulsed transistor delivers an impressive 800 W output power. Another pulsed device for L-band radar, the model IB1214M370, provides 370 W of pulsed power from 1200 to 1400 MHz. In the area of S-band radar, the firm's model IB3000S200 is designed for boosting 12-µs pulses at a 1-percent duty cycle. It is optimized to produce 200 W output power at 3 GHz. These devices represent a small sampling of the transistors on the company's website.

PLEASE COMMENT

Microwaves & RF welcomes mail from its readers. Letters must include the writer's name and address. The magazine reserves the right to edit letters appearing in "Feedback." Address letters to:

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S4W2	S4W5	N4W5	4	±0.40
S5W2	S5W5	N5W5	5	±0.40
S6W2	S6W5	N6W5	6	±0.40
S7W2	S7W5	N7W5	7	±0.60
S8W2	S8W5	N8W5	8	±0.60
S9W2	S9W5	N9W5	9	±0.60
S10W2	S10W5	N10W5	10	±0.60
S12W2	S12W5	N12W5	12	±0.60
S15W2	S15W5	N15W5	15	±0.60
S20W2	S20W5	N20W5	20	±0.60
S30W2	S30W5	N30W5	30	±0.85
S40W2	S40W5	N40W5	40	±0.85

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UWB Must Survive The Format Wars

WIRELESS TECHNOLOGIES TEND TO spring up quickly, but often do not take root until the adoption of a standard. For one thing, integrated-circuit (IC) suppliers are reluctant to commit to a proposed technology if there is some uncertainty about how long that technology will be in use. Through the acceptance of a standard, the industry is (for the most part) acknowledging that one method is superior than alternative approaches and will thereby support that method in their own products.

UWB holds the promise of extremely high data rates for short-range, low-power communications.

Ultrawideband (UWB) technology holds the promise of high data rates for short-range, low-power communications. Some companies have promoted (hyped?) UWB as THE wireless multimedia technology of the future, pointing to its generous data rates as ideal for short-range video transmissions. But as with any wireless communications technology, there is a "rite of passage" for UWB before it can be accepted by an industry of chip and instrument makers, just as there had been for wireless local-area networks (WLANs) before it.

Some engineers currently involved with UWB painfully remember the issues leading to the eventually establishment of WLAN standards. Long debates within IEEE task group meetings on the merits of frequency-hopping spread spectrum (FHSS) versus direct-sequence spread spectrum (DSSS) begrudgingly led to compromises and the final acceptance of the first WLAN standard at 2.4 GHz, IEEE 802.11b. One of the driving considerations for that standard was the FCC's requirement that any WLAN solution must favor coexistence with established ISM-band applications over bandwidth efficiency.

Since there were compromises on the available data rate, and the FCC eventually relaxed its requirements on coexistence, later WLAN standards (802.11a and g, for example) pursued improved bandwidth efficiency. But the initial debates delayed WLAN technology, and cost manufacturers market time. Without a relatively fast resolution to the UWB debates, the same fate could await this novel technology.

The many original proposals for UWB technology (see p. 33) as a wireless personal-area network (WPAN) have apparently come down to two groups: the XtremeSpectrum/Motorola "wideband" version and the Multiband OFDM Alliance (MBOA) "narrowband" version (backed by Intel, Texas Instruments, and others). Both provide huge amounts of data with very little power, albeit with different modulation approaches. If one is a standard, the other is not. But with a standard at hand, chip suppliers, software developers, test-equipment makers, and others involved in the commercialization of UWB technology can move forward and help UWB bypass the market-slowing indecision that haunted the early days of WLANs.

Jack Browne

Publisher/Editor

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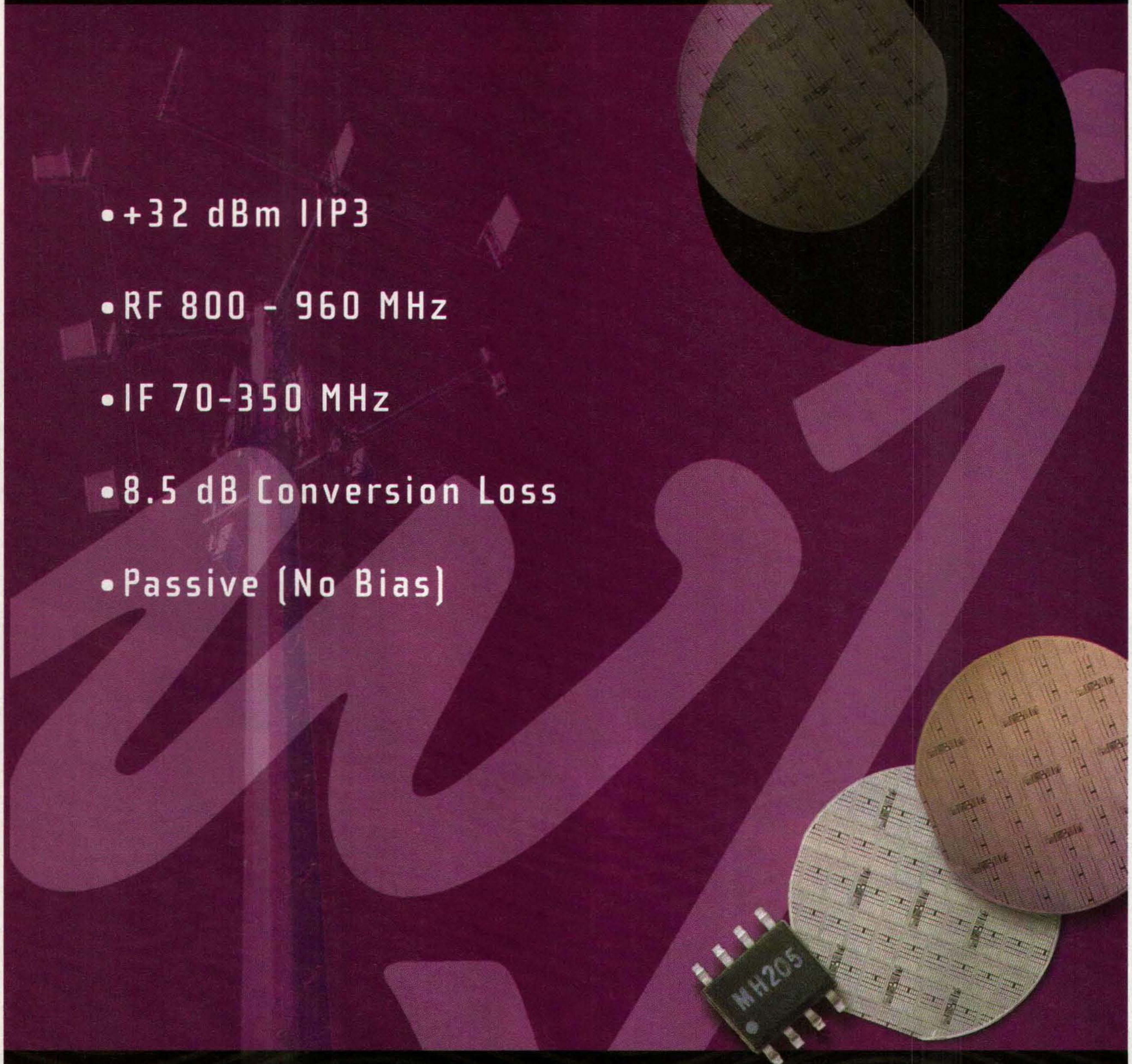

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MH202	17 dBm	890-960	640-760	200-250	8.5 dB	+30 dBm	45 dB
MH203	17 dBm	800-960	1100-1310	200-350	8.5 dB	+32 dBm	45 dB
MH205	17 dBm	800-915	700-845	70-120	8.5 dB	+32 dBm	45 dB

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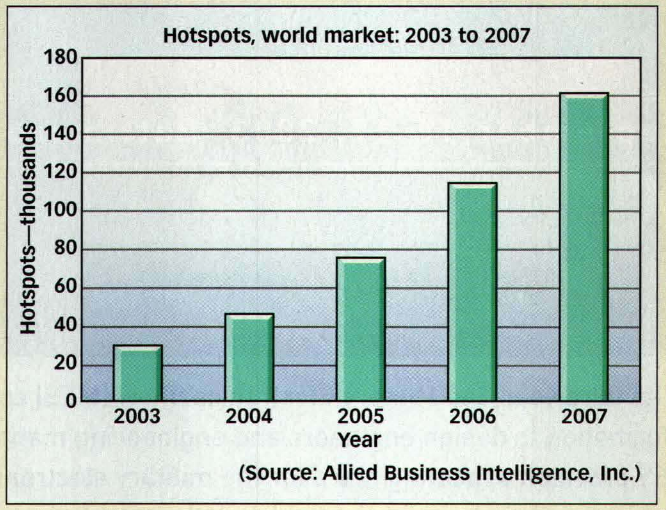
Continued Consumer Adoption Holds Answer To Success Of Hotspots

OYSTER BAY, NY—Public Wi-Fi hotspots continue to garner the attention of a wireless industry searching for answers and opportunities. There is tremendous momentum building, but this should not be mistaken for over-hype, as many players in the market are facing the reality of commercial deployments. Though there exist business models that are working, there continue to be areas that need improvement.

Some of the issues facing the hotspot industry range from interoperability between hotspot locations to the need for operators and aggregators to acquire more users.

Selling Wi-Fi services combined with cellular and other operator offerings could help stimulate consumer interest in hotspots. "There are some terrific opportunities for operators to start bundling services, offering consumers a more data-intensive usage model, as well as a more compelling package of benefits and value," says Tim Shelton, Allied Business Intelligence, Inc.'s (ABI's) director of wireless research.



ABI projects that worldwide hotspots will grow to over 160,000 locations by 2007, from approximately 28,000 in 2003 **(see figure)**. These numbers have a potential of being higher, depending on consumer adoption.

ABI's report, "Wi-Fi Public Hotspots: Business Case Analysis through Deployment and Subscriber Forecasts," investigates the market, looking for areas of growth and what pitfalls may lie ahead.

Ansoft Offers Free Downloadable Ansoft Designer SV

PITTSBURGH, PA—Ansoft Corp. has made available Ansoft Designer™ SV, a free, full-featured linear simulator for high-frequency microwave and RF circuit and system design.

Ansoft Designer SV, available for download at www.ansoft.com/ansoftdesignersv, provides engineering professionals and students with linear frequency-domain circuit-simulation technology and a design environment that are comparable to that of the commercial version of Ansoft Designer.

"Ansoft's high-frequency software tools have been at Syracuse University for years in both coursework and research on antennas, filters, and amplifiers. With the release of Ansoft Designer SV, we look forward to providing even greater benefit to our microwave engineering students as well as our ongoing work with industry leaders," comments Dr. Ercument Arvas, professor at Syracuse University. "By providing this version of Ansoft's high-frequency circuit-design tool, our students have the opportunity to develop practical designs while becoming proficient at using commercial-grade design software."

Design professionals can fully incorporate the linear designs that they create in Ansoft Designer SV into the commercial version of Ansoft Designer and HFSS™, Ansoft's industry-standard software for 3D electromagnetic (EM) design and analysis. This allows engineers to create a greater number of designs in Ansoft software without having to purchase and learn how to use additional software that is not compatible with the Ansoft desktop.

Modern Radio Network Will Be Installed On Würzburg Trams

MUNICH, GERMANY—R&S Bick Mobilfunk, a Rohde & Schwarz subsidiary, will set up a TETRA radio system for Würzburg, Germany's trams on behalf of Siemens Transmit Telematic Systems AG (Siemens TTS) of Neuhausen, Switzerland. It will serve as the backbone of a computer-controlled traffic-management system that will keep passengers at central stops up to date with relevant information, such as departure times. In addition, the operating personnel and tram drivers will use the TETRA system as a voice-communication network. The TETRA network and its wide range of possible applications can considerably lower operating costs needed for communication.

If public urban mass transit wants to keep pace with individual private transportation, it must provide attractive service. For this reason, Würzburg's tram company commissioned Siemens TTS to install a modern computer-controlled traffic-management system. One of its components is the TETRA radio system, which provides location-independent data and voice communication and ensures that buses and trams can communicate with the control center. The new radio system is scheduled to go into operation in March 2004; its integration in the traffic-management system will be completed in the summer of 2004. The ACCESSNET®-T system with five locations will cover the entire area served by Würzburg's trams. The network comprises an exchange with an integrated TETRA base station and four other TETRA base stations.

"The new system provides passengers with a plethora of information, such as a real time indication of departure and arrival times."

The new system provides passengers with a plethora of information, such as a real time indication of departure and arrival times. An onboard computer in each vehicle provides the traffic-management system with location information, which is transmitted in real time to the information displays (*SmartInfos*) at tram stops via the radio system. Altogether, 20 such *SmartInfo* display systems with loudspeakers are to be installed at the most important interchange points. For the operating staff and the tram drivers, using the TETRA network is as convenient as using a telephone. This is made possible by duplex radio devices: users can speak at any time without having to hold down a push-to-talk key. The size of the latest generation of handheld radio devices is also comparable to mobile phones.

Analog Devices And IBM Team For New Family Of DSPs

SAN JOSE, CA—Analog Devices, Inc. announced that the memory system of its next-generation TigerSHARC® Processor features embedded dynamic random-access memory (DRAM) from IBM Microelectronics. With up to three times the on-chip memory of its closest competitors, ADI's TigerSHARC ADSP-TS201/202/203 family enables designers of the most demanding signal-processing applications to achieve superior performance density at lower cost and power consumption than with SRAM-based solutions.

"Our collaboration with IBM has resulted in a new class of DSP—one that integrates innovative DRAM technology with an advanced multiprocessing architecture," says Brian McAloon, group vice president and general manager for DSP and system products at Analog Devices, Inc. "Adding embedded DRAM-based products to our TigerSHARC family further strengthens our performance density leadership in signal-processing devices, allowing us to address an even-broader range of customers designing applications, such as next-generation base stations, 3D imaging systems, and radar and sonar applications."

"IBM and ADI worked hand-in-hand to integrate our advanced embedded DRAM technology with ADI's processor," states Michael Concannon, vice president of foundry services at IBM Microelectronics. "The strength of IBM's chip business is the combination of advanced technologies and design with a leading-edge foundry, enabling our customers to differentiate their products and get them to market fast."

Embedded DRAM delivers three distinct advantages over static random-access memory (SRAM) solutions for large embedded-memory DSPs: lower cost, better performance, and higher system-level reliability. Occupying approximately one quarter of the die area of SRAM, embedded DRAM directly lowers cost. Embedded DRAM reduces power consumption because embedded DRAM leakage per bit is less than 1/100th that of SRAM. In addition, embedded DRAM has much higher system-level reliability due to low susceptibility to memory system errors, known as soft-error rates (SERs). The SER of embedded DRAM is more than 1000 times better per bit than SRAM.

Mobile Operators Must Choose Proper Pricing For MCE Services

CAMBRIDGE, ENGLAND—Mobile operators and mobile virtual network operators (MVNOs) could miss out on a large chunk of revenue (up to 16 percent) if they do not choose the most appropriate pricing policies for messaging, content, and entertainment (MCE) services, according to report from Analysys, a global adviser on telecommunications, IT, and media.

The report, *Pricing Mobile Messaging, Content and Entertainment Services: a structured approach to maximising revenue*, concludes that the pricing of MCE services could have a dramatic effect on overall mobile revenue and average revenue per user (ARPU).

"The pricing that operators adopt for MCE services could substantially affect not just their revenue from those services but also their overall service revenues. We estimate that there could be a difference in an operator's total mobile revenues of 16 percent between the most appropriate and least appropriate MCE pricing strategies," explains Eddie Murphy, author of the report. "Choosing the right strategy will be key, and the right strategy will vary from operator to operator according to their approach to content, their position in the market, and the strength of their international alliances."

"The pricing that operators adopt for MCE services could substantially affect not just their revenue from those services but also their overall service revenues."

MCE services are already an important part of the Western European mobile market, with 12 percent of the region's total mobile revenues [EUR12.5 billion (approximately $14.1 billion US) in 2002] coming from such services as person-to-person messaging, mobile instant messaging, games, music and video clips, news and location services, ringtones, logos, and content messaging. By 2008, revenue for these services is forecast to rise to EUR35 billion [approximately $39.6 billion US] (23 percent of total mobile revenues).

However, the report states that action is needed in the short term, to counter the recent dramatic slowdown in growth of mobile voice revenue. Mobile operators will need to focus their attention on growing MCE services as quickly as possible—and pricing is a critical factor.

"There is no scope for complacency," warns Murphy. "The strategic approach for MCE services needs to be clearly established for 2.5G platforms in advance of 3G service offerings. Waiting for 3G to determine the appropriate strategies will be too late."

Kudos

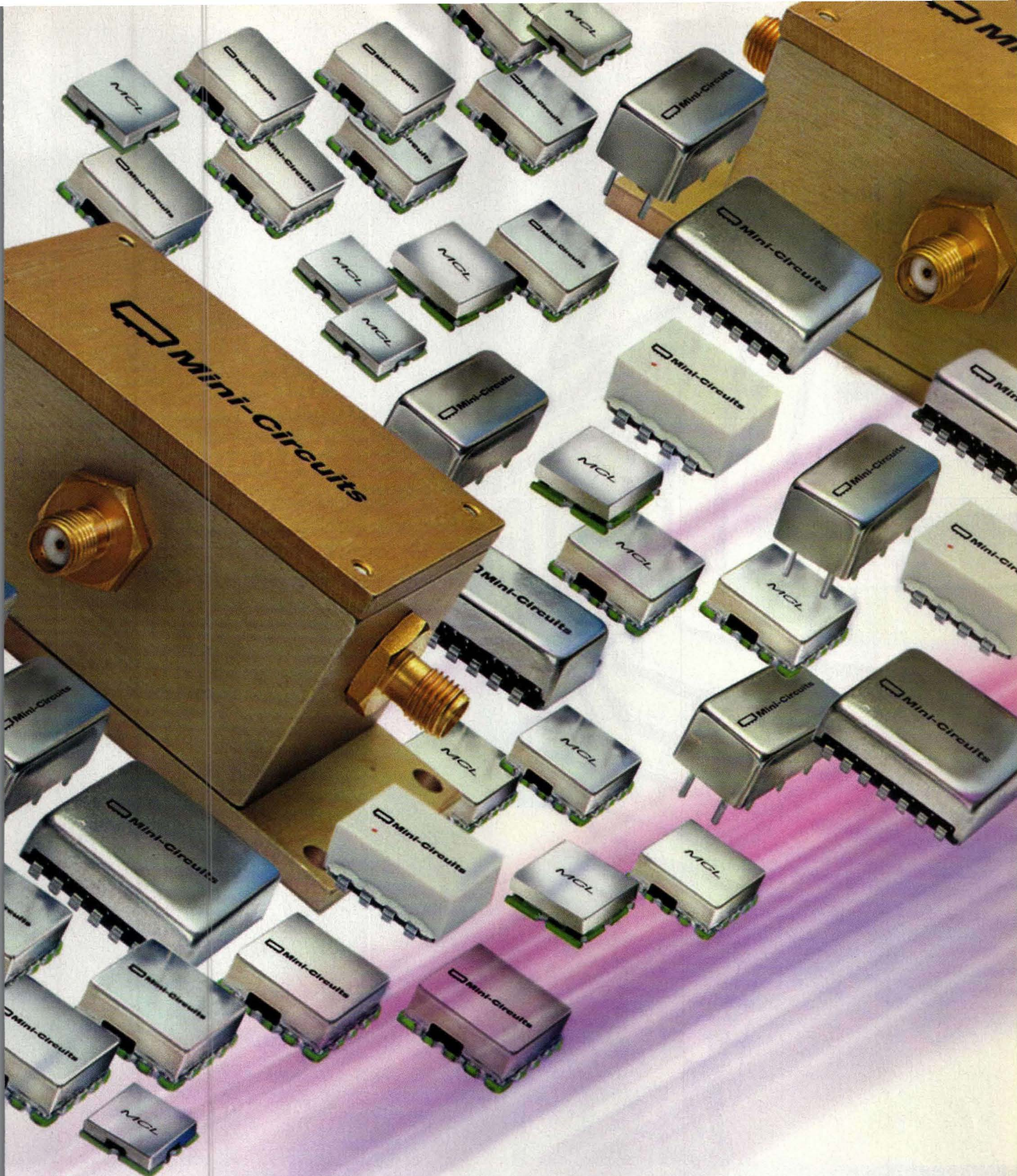
CLEVELAND, OH—Keithley Instruments, Inc. has been recognized by the Northeast Ohio Technology Coalition (NorTech) for two recent product innovations. Keithley received the two 2003 NorTech Innovation Awards for its Model 2701 Ethernet-based DMM/Data Acquisition System and its Model 2800 RF Power Analyzer. The annual awards competition awards individuals and companies that have created and implemented Northeast Ohio's best innovations.

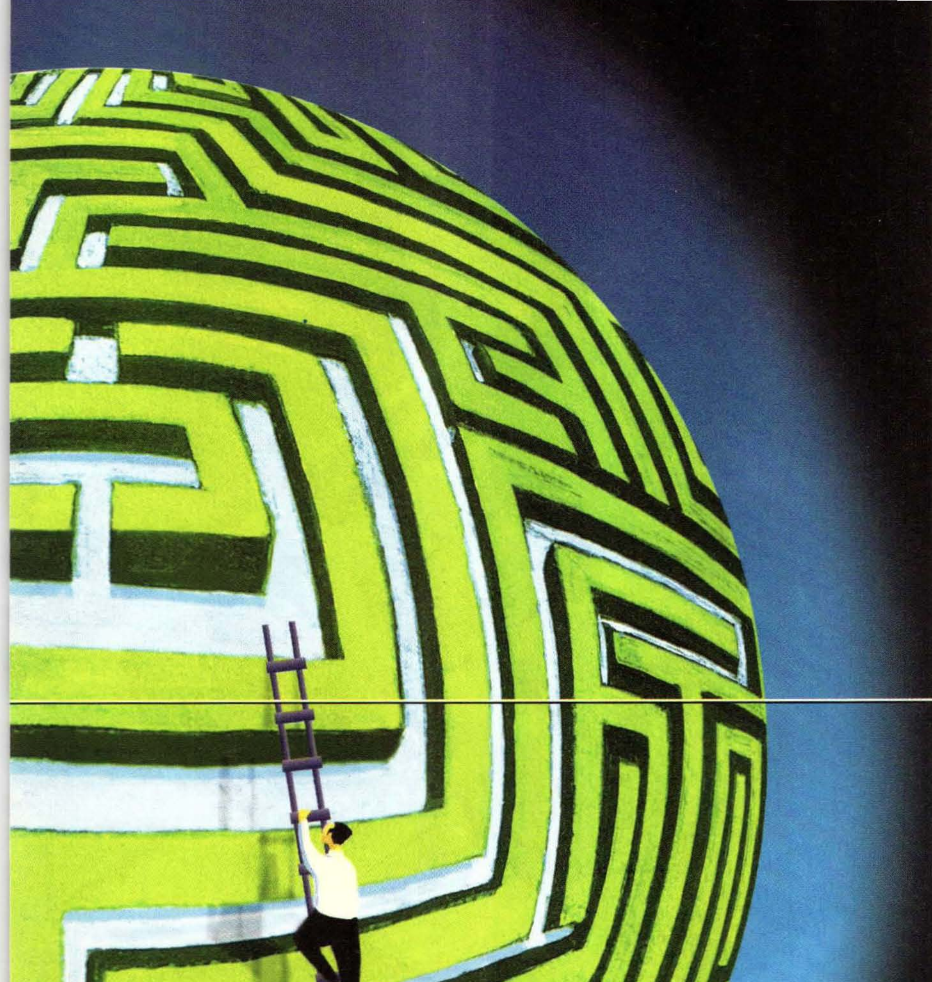
IRVING, TX—Elcoteq Network Corp., a provider of electronics manufacturing services (EMS) for the communications-technology industry, announced that Elcoteq Americas facility in Monterrey, Mexico has achieved a World-Class Quality Level based on the GE Quality Assessment. The GE process assessment is a tool for analyzing a company's manufacturing performance level.

PHILADELPHIA, PA—Semflex, Inc., a manufacturer of coaxial cable for the telecommunications, mil/aero, and test instrumentation markets, announced that the company has been certified to the latest ISO9001:2000 standard through DNV (Det Norske Veritas). ISO9001:2000 is a worldwide quality standard that encompasses every facet of business operations across all industries.

WARREN, NJ—ANADIGICS, Inc., a supplier of wireless- and broadband-communications solutions, announced that they have shipped more than one million InGaP HBT power amplifiers (PAs) since its announcement of the acquisition of a wireless-local-area-network (WLAN) PA product line in April 2003.

AUSTIN, TX—Wireless Valley announced that its chairman and CEO, Dr. Ted Rappaport, has been named to a National Academy of Sciences committee that will conduct a comprehensive study on the role and current scope of research and development (R&D) of telecommunications in the US. Prof. Rappaport, who holds the William and Bettye Nowlin Chair in Engineering and is the director of the newly formed Wireless Networking and Communications Group at the University of Texas in Austin, is one of 18 experts from academia and industry named to the committee. Rappaport was also named to the Federal Communications Commission (FCC) Technological Advisory Council (TAC), which will provide independent technical advice to the FCC on issues and questions involving telecommunications policy in the US. MRF


Mini-Circuits
MCL



NEWS

UWB Proponents Seek Standardization

The promise of low-cost chips, low-power transmitters, and high data rates has major communications companies scrambling to learn the potential of UWB technology.

JACK BROWNE
Publisher/Editor

Wireless "standards keepers" have kept a strong collective eye on the emerging technology known as ultrawideband (UWB) communications, perhaps as much for fear that it could interfere with existing wireless formats as much as for fear that it could become a viable, high-data-rate wireless option. Almost a year and a half after the US Federal Communications Commission (FCC) gave a green light for the use of about 7 GHz of bandwidth for low-power UWB transmitters and receivers, a number of significant players, including Intel, Motorola, and Taiyo Yuden, have announced their intentions to compete in the UWB playground. The future of the technology may depend on how well it can coexist with more established wireless formats, or possibly how quickly it can replace them.

By adopting a First Report and Order last February, the FCC permitted the marketing and operating of certain types of UWB devices, in about 7 GHz of spectrum from 3.1 to 10.6 GHz. That First Report and Order includes standards to protect the operation of existing and proposed radio services from interference caused by UWB devices. In contrast to a conventional communications system in which transmitted energy is focused within a relatively narrow band or channel, an UWB system spreads its transmissions over a fairly wide bandwidth but with a lower effective power level than in a conventional radio channel.

The technology is yet another development of military laboratories to find its way to commercial manufacturers, much like Global Positioning System (GPS) receivers and code-division-multiple-access (CDMA) technology for cellular telephones. The promise of sending high rates of data over low-cost, low-power UWB links has attracted numerous small and large companies and investors, and almost as many proposed "standards." To help sort through the different slants on UWB technology, the Institute of Electrical and Electronics Engineers (IEEE) 802.15.3 Task Group (www.ieee.org/groups/802/15/) is chartered to draft a new standard for wireless personal-area networks (WPANs). The proposed IEEE 802.15.3a specification (expected to be final in late 2004) will include a standard physical-layer definition for short-range, low-power, high-data-rate (100 Mb/s and more) WPANs.

A total of 23 proposals for the new UWB standard were submitted during a March IEEE meeting (from 31 original presentations), representing a variety of different modulation formats. In essence, the proposals fall into two camps on the use of the FCC's allotted bandwidth. One seeks to achieve high data rates at

low power levels, without necessarily limiting the amount of FCC-allotted bandwidth that is occupied. The other favors a more "narrowband" use of spectrum, at first concentrating on the spectrum from 3.1 to 4.8 GHz, and then moving upward in frequency when the technology becomes more cost-effective at those higher frequencies.

With last month's meeting of the IEEE 802.15.3a Task Group, one of the proposals stood out as the leading candidate for the final IEEE 802.15.3a standard. The proposal is based on orthogonal frequency-division multiplexing (OFDM) and backed by the Multiband OFDM Alliance (MBOA). The alliance was formed just this June, and includes one of the UWB pioneers, Time Domain Corp. (www.timedomain.com), as well as some leading electronics suppliers, such as Focus Enhancements, Intel, Mitsubishi, Panasonic, Philips, Samsung, and Texas Instruments. Although the proposal garnered only 60 percent of the required 75 percent of the group's vote for confirmation of a standard, the MBOA plans to address task-group members' reservations (including compliance with FCC regulations) in time for the next meeting/vote in September.

Time Domain's PulsON 200 UWB evaluation kit is one of the first commercial UWB products to be marketed by any alliance member. It includes two of the company's UWB radios, a dedicated microprocessor for embedded applications development, a power supply, biphase pulse modulator, antenna, and several software tools. The kit operates over a 3.2-GHz bandwidth centered at 4.7 GHz with −11.5-dBm effective isotropic radiated power (EIRP) and pulse-repetition frequency of 9.6 MHz. It can achieve data rates ranging from 75 kb/s to 9.6 Mb/s.

Of course, one of the other UWB pioneers, XtremeSpectrum (www.xtremespectrum.com), remains outside of the MBOA, and with a rival proposal based on a different modulation and access scheme, direct-sequence CDMA (DS-CDMA). The company's Trinity chip set remains the only UWB chip set on the market, consisting of an RF front-end integrated circuit (IC), RF transceiver, MAC IC, and digital baseband IC. Constructed with silicon CMOS and silicon-germanium (SiGe) semiconductor process technologies, the chip set operates within the FCC's Class B limits for transmissions at less than 1 mW from 3.1 to 10.6 GHz. Although not an MBOA member, the company does have a formidable backer in Motorola (www.motorola.com). Also in support of the XtremeSpectrum chip set, several months ago Taiyo Yuden (www.t-yuden.com) announced that it had developed a ceramic chip antenna capable of transferring streaming video in UWB systems operating from 3.1 to 10.6 GHz.

The MBOA proposal is firmly rooted in UWB studies performed by Texas Instruments and Intel. Intel's interest in UWB technology, for example, is very much as a "next-generation Bluetooth" option capable of higher data rates than Bluetooth. The company is currently exploring the possibility of installing UWB technology on every microprocessor, and using UWB as the wireless connectivity approach between devices—rather than as a wireless networking tool, such as the IEEE 802.11 a/b/g WLAN standards. The company's website offers "Ultra-Wideband Technology for Short- or Medium-Range Wireless Communications" by Jeff Foerster and associates from the Intel Architecture Labs with an excellent analysis of data throughput for various UWB approaches.

At the May IEEE 802.15.3a Task Group meeting, TI's physical layer presentation on "Time-Frequency Interleaved Orthogonal Frequency Division Multiplexing (TFI-OFDM)" proposed the use of three bands centered at 3432, 3960, and 4488 MHz. Each band features 528-MHz bandwidth, with each OFDM symbol occupying more than 500 MHz at all times (as required by the FCC), and using average transmit power of –10.3 dBm per band. The approach is capable of data rates from 55 to 480 Mb/s.

TI's proposed system can actually support as many as 14 UWB bands of 528 MHz, although signal losses increase at higher frequencies, and thus the interest in the lower frequencies. The TFI-OFDM system avoids all transmission in the 5-GHz UNII band (currently occupied by IEEE 802.11a WLANs), and offers simple implementation in standard digital complementary metal-oxide semiconductor (CMOS) and simpler antennas than the broadband designs required for more broadband UWB systems.

Come September, the IEEE 802.15.3a Task Group may help to establish a WPAN standard. It should be noted that such as standard does not by any means represent the only use of UWB technology. In its First Report and Order (February 14, 2002), the FCC (www.fcc.gov) detailed a wide range of applications for UWB technology, including medical-imaging systems, ground-penetrating-radar (GPR) systems (which must be operated below 960 MHz or from 3.1 to 10.6 GHz), wall imaging systems (with similar frequency restrictions as GPRs), through-wall imaging systems (which must be operated below 960 MHz or from 1.99 to 10.6 GHz), medical systems, and surveillance systems (which must operate from 1.99 to 10.6 GHz). Additional applications include vehicular radar systems in the 24-GHz band, and communications and measurement systems from 3.1 to 10.6 GHz. MRF

Plug-In Connector Interface Operates To 6 GHz

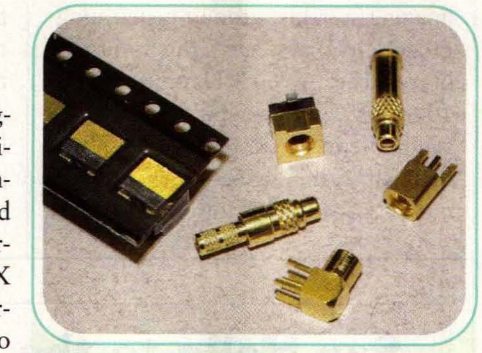
THE MMCX INTERFACE represents a significant expansion to a line of microminiature RF connectors. The snap-on connector eliminates the need for a threaded connection while ensuring reliable operation from DC to 6 GHz. The MMCX connector interface, which has an operating temperature range of –55 to +155°C, has a characteristic impedance of 50 Ω and durability of 500 cycles. The return loss is at least 20.8 dB to 6 GHz. The durability and performance of these new connectors makes them well suited for a wide range of applications, including wireless communications, telematics and automotive systems, and other commercial applications. The connectors are priced according to a standard cable plug to straight printed-circuit-board (PCB) jack mated pair or a standard straight cable plug to PCB jack mated pair. P&A: $2.25 (5000 qty.); stock.

Tyco Electronics, P.O. Box 3608, Harrisburg, PA 17105; (717) 592-2316, Internet: www.tycoelectronics.com.

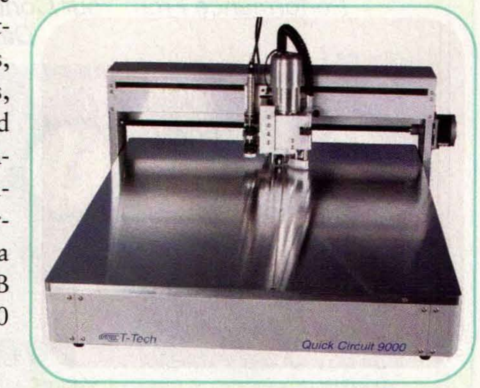
System Prototypes Antennas, Large Circuits

THE QUICK CIRCUIT 9000 rapid circuit prototyping system is specifically designed for large work areas. Supporting work areas of 19 × 19 in. (480 × 480 mm), the Quick Circuit 9000 is ideally suited for fast fabrication of antennas and large RF/microwave circuits. The system, which features a pneumatically activated, speed-controlled Z-axis, provides in-house drilling, milling, and routing based on processing connected computer-aided-design (CAD) and computer-aided-manufacturing (CAM) digital files.

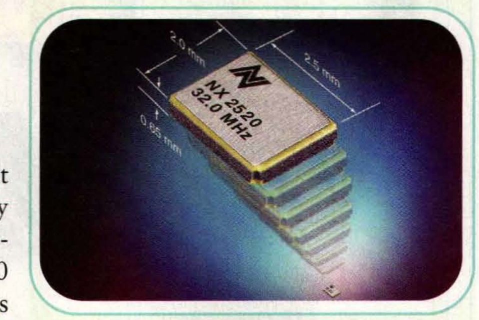
T-Tech, Inc., 510 Guthridge Court, NW, Atlanta, GA 30092; (770) 455-0676, FAX: (770) 455-0970, Internet: www.t-tech.com.



TYCO'S MMCX CONNECTOR INTERFACE



T-TECH'S QUICK CIRCUIT 9000 PROTOTYPING SYSTEM



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Miniature Crystals Resonate To 80 MHz

MINIATURE SURFACE-MOUNT crystal resonators in the NX2520DA series measure only 2.5 × 2.0 × 0.6 mm but provide fundamental frequencies from 20 to 80 MHz at operating temperatures from –10 to +60°C. Standard crystal frequencies include 20.000, 22.5792, 24.000, 27.000, 28.63636, 32.000, 40.000, 44.000, and 48.000 MHz. The frequency tolerance is ±10 PPM to ±100 PPM while the equivalent series resistance is 100 Ω from 20 to 30 MHz and 50 Ω from 30 to 80 MHz. The tiny resonators are supplied in a ceramic-based, metal-covered lead-free package. P&A: $0.65 (10,000 qty).

NDK America, Inc., 47671 Westinghouse Dr., Fremont, CA 94539; (800) 635-9825, FAX: (510) 623-6590, Internet: www.ndk.com.

Analyzer Checks Bluetooth V1.2 Protocols

VERSION 2.1 OF THE BTTRACER/TRAINER is the first commercial Bluetooth analyzer capable of complete capture, decoding, and analysis of version 1.2 of the Bluetooth protocol. The analyzer offers a new auxiliary channel that allows the capture of mixed piconets and full automation support through a DCOM interface. Draft 4 of the Bluetooth Version 1.2 specification was released May 23, 2003 and is supported by the BTTracer/Trainer's capabilities in performing scatter-mode analysis, anonymity mode analysis, absence masks, and L2CAP flow and error-control analysis. The protocol analyzer is controlled by means of the company's CATC Trace expert analysis software, which offers an intuitive and easy-to-use graphical user interface.

Computer Access Technology Corp., 2403 Walsh Ave., Santa Clara, CA 95051-1302; (408) 727-6600, FAX: (408) 727-6622, e-mail: sales@catc.com, Internet: www.catc.com.


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Aeroflex Agrees To Acquire MCE

AEROFLEX, INC., A DESIGNER, developer, and manufacturer of automated testing solutions and microelectronics for the aerospace, defense, and broadband-communications markets, announced that it has entered into a definitive agreement to acquire MCE Technologies, Inc. for approximately 5,850,000 shares of Aeroflex common stock. In addition, Aeroflex will retire approximately $25 million in MCE outstanding bank and other indebtedness. MCE designs, manufactures, and markets a range of microelectronics devices, components, and multifunction modules servicing wireless, broadband-infrastructure, satellite-communications, and defense markets.

The transaction is subject to regulatory approval and it is anticipated that the merger will be completed by October 31, 2003.

"We are pleased that MCE's board of directors has unanimously endorsed, and recommended that MCE shareholders approve, this transaction," says Michael Gorin, president of Aeroflex, Inc. "MCE will be integrated into our Microelectronic Solutions Group and will allow us to leverage MCE's extensive RF and millimeter-wave device technologies with our world-class packaging and thin-film interconnect technologies.

"MCE brings to Aeroflex a strong, seasoned management team with a track record of successful execution," continues Gorin. "Its broad range of products complements ours and offers us a significant opportunity for both technology and cross-selling synergy. For its most recently completed year ended December 31, 2002, MCE had sales of approximately $63 million with profitable operations. We expect MCE to be accretive to our earnings."

Aeroflex Inc.'s common stock trades on the Nasdaq National Market System under the symbol ARXX and is included in the S&P SmallCap 600 index.

In connection with the proposed transaction, Aeroflex and MCE will file a proxy statement/prospectus with the US Securities and Exchange Commission.

Additional information about Aeroflex, Inc. can be found on the company's website at www.aeroflex.com. MRF

CONTRACTS

TECOM Industries, Inc.—Announced that it has been awarded a major contract for a total of $2,145,000 by Iridium Satellite LLC in Arlington, VA. Under this contract, TECOM will produce a total of 30,000 antennas for the Iridium handset phones, widely used for both military and commercial applications.

ITT Industries—Has been awarded a $43 million Northern Communications (NorthernComm) contract by the US Air Force Europe (USAFE) to provide communications support to various locations in Northern Germany and the United Kingdom. Contract work will be performed by ITT's Systems Division, located in Colorado Springs, CO.

On NorthernComm, ITT will perform multiple communications functions including microwave and systems control equipment operations and maintenance, Land Mobile Radio maintenance, Alerting System maintenance, local-area-network (LAN) support, and Defense Messaging System oversight.

Harris Corp.—Has delivered FALCON® II AN/PRC-117F multiband radios to the United Kingdom Ministry of Defence (UK MoD) as part of an Urgent Operational Requirement (UOR). This $5.3 million contract marks the fourth order for AN/PRC-117F radios by the UK MoD since 2000.

The UK MoD initiated the UOR for Harris' FALCON II AN/PRC-117F multiband tactical radio systems to fulfill a critical mission requirement. They will be used by the UK MoD Permanent Joint Headquarters to augment headquarter communications for current operations in the Middle East. The radios, delivered in February and April, were chosen for this mission because of features such as multi-role operation, US interoperability, high-grade Type 1 encryption, and UHF tactical satellite-communications operational ability.

Herley Industries, Inc.—Announced that it has received a $1 million contract to supply power amplifiers (PAs) in support of a military airborne communications program.

FRESH STARTS

Renaissance Electronics Corp.—Has acquired the Ferrite: Circulator, Isolator, and Attenuator product lines of MCCI Wireless and P&H Laboratories.

MCCI Wireless and P&H Laboratories' business systems (Sales and Contracts) are being relocated to Renaissance Electronics headquarters in Harvard, MA.

Agilent Technologies, Inc.—Received a government grant from the Taiwan Ministry of Economic Affairs (MOEA) to spur communications product research and development (R&D) through an initiative called the Agilent Integrated Platform Service Project. The Agilent project helps Taiwan-based business ventures cooperate with international companies to either bring state-of-the-art technologies to communication product design R&D houses within Taiwan or co-develop technologies with foreign consulting teams.

The project is one part of the Taiwan MOEA SiSoft initiative, which defines an RF system-on-a-chip (SoC) design and verification platform and provides consulting services to benefit the nation's communications product-design industries. The Agilent initiative outlines a service architecture customized for Taiwan's RF SoC design industry, an RF SoC design flow, and a training program for Taiwan's RF SoC personnel.

Sonnet Software, Inc.—Announced the relocation and expansion of the company's North American and corporate headquarters within the Syracuse, NY area. The new offices are located at 100 Elwood Davis Rd. in North Syracuse, NY, and will retain all software-development, North American support, and North American sales activities.

EMS Technologies, Inc., Space & Technology/Montreal Division—Has recently delivered the last of three Inmarsat-4 L-Band Antenna Feeds to Astrium Ltd. in Portsmouth, England.

These antenna feed arrays are designed, manufactured, and tested by EMS Technologies for the Inmarsat-4 program. The Inmarsat-4 antennas are highly complex, Passive Intermodulation (PIM)-free, 120-element, combined transmit/receive L-Band Arrays.

The Inmarsat-4 antennas have been designed to support high-speed (up to 432 kb/s) mobile Internet access, video-on-demand, video conferencing, fax, and e-mail for companies across the Americas, Europe, Africa, and Asia through the INMARSAT Broadband Global Area Network (BGAN) program.

Maury Microwave Corp.—Signed an agreement with Inter-Continental Microwave (ICM) to jointly promote and sell the ICM line of Test Fixture Solutions.

The ICM fixtures work hand in hand with Maury's full line of Load Pull and Noise Characterization Tuner Systems. Maury provides high-speed Solid State Tuner Systems (SSTS), high power/high matching range, low loss, mechanical tuner systems (ATS), and combined mechanical/solid-state systems (Multi-mode) for high matching ranges with high-speed applications. ICM fixtures are available separately or as part of a Maury turn-key RF Device Characterization System.

Phihong—Moved their Taiwan headquarters to a new and expanded facility in Taipei, The new 128,000-sq.-ft. building will house the company's expanded research-and-development (R&D) team, as well as additional sales and engineering support staff.

The contact information for the new Taiwan office is: No. 568, Fu Xing San Rd., Gui Shan, Tao Yuan Hsien, Taiwan, R.O.C.; 886-3-32777288, FAX: 886-3-3185999, e-mail: phsales@phihong.com.tw. MRF


PEA

TRAK Microwave Appoints Richard Pea To VP Spot

TRAK Microwave, a TRAK Communications Co., has named RICHARD (DICK) PEA as vice president of the Government Strategic Business Unit. Pea is responsible for all business aspects of the unit, including contracts, programs, engineering, and sales.

Endwave Corp.—ART ARRINGTON to vice president for worldwide manufacturing operations and site manager for the Diamond Springs facility; formerly director of manufacturing. Also, MARK HEBEISEN to vice president of marketing; formerly vice president of technology and business development at Signal Technology's Wireless Group (SWG). In addition, STEVE LAYTON to vice president of sales; formerly director of sales. And, DAN TEUTHORN to vice president of engineering; formerly director of engineering.

Broadband Services, Inc.—BOB WEATHERFORD to vice president of National Accounts, East; formerly senior account manager at i2 Technologies.

Broadcom Corp.—ROBERT E. SWITZ to the board of directors; continues as executive vice president and CFO at ADC Telecommunications, Inc.

SIRIUS—DAVID J. FREAR to executive vice president and CFO; formerly executive vice president and CFO for SAVVIS Communications.

Motorola, Inc.—SCOTT ANDERSON to president of the Semiconductor Products Sector (SPS); formerly president of the Transportation and Standard Products Group (TSPG). Also, PAUL GRIMME to president of the TSPG; formerly corporate vice president and general manager of TSPG's 8/16-b Product Division.

Zyray Wireless—DR. MARK KENT to director of systems engineering; formerly WCDMA baseband ASIC system architect at Skyworks.

Tektronix, Inc.—TODD BIDDLE to vice president and general manager of the company's Video Product Line; formerly general manager of Tektronix's Video Business.

AM Communications, Inc.—KENNETH "CHIP" WILTSE to president and CEO; formerly president of AM Broadband Services, Inc. Also, JAVAD K. HASSAN remains as chairman of the board of directors; formerly CEO.

Recognition Source—LESTER LAPIERRE to national sales manager for OEM accounts; formerly regional sales manager for Eastern US and Canada at Indala Corp.

Richardson Electronics—WILSON LEE to vice president of Asia Pacific sales; formerly managing director of Asia Pacific sales.

ITT Industries, Inc.—MARK E. LANG to corporate controller; formerly vice president for finance and controller at ITT's Fluid Technology unit.

LEDtronics—EDWIN TAYLOR to sales representative for Canada; formerly employed in electronics, manufacturing, and sales positions.


TAYLOR


CARLSON

Park Electrochemical Corp.—MARK CARLSON to business director for global RF/microwave materials; formerly Eastern regional account manager at Isola Laminating Systems.

Harris Corp.—HOWARD L. LANCE to chairman of the board; remains as president and CEO. MRF

►SHORT COURSES

Indoor Networks: Principles & Practice of In-Building Wireless Engineering
September 11-12 (San Francisco, CA)
For further information, contact:
Dr. Eric Reifsnider
(540) 818-2281
e-mail: training@wirelessvalley.com
Internet: www.wirelessvalley.com/Services/Training.asp

Planning and Implementing Point-To-Point Microwave Radio Systems
October 7-9 (Madison, WI)
The University of Wisconsin-Madison, Department of Engineering Professional Development
(800) 462-0876
e-mail: custserv@epd.engr.wisc.edu
Internet:
http://epdweb.engr.wisc.edu/webE788

Antenna Measurement & Techniques Association (AMTA) 2003 Short Course: Selected Topics from Veteran AMTA Speakers
October 19-24 (Irvine, CA)
Hyatt Regency Hotel
For further information, contact:
John Demas
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Model The Intermodulation Distortion Of Microwave Transistors

MODELING THE INTERMODULATION behavior of high-power microwave transistors provides the insights and advantages needed to develop first-iteration amplifier designs for commercial and military applications. Research performed by F. Giannini and associates from the Dipartimento di Ingegneria Elettronica of the Universita Tor Vergata (Rome, Italy) has led to the development of a nonlinear model based on modular neural network techniques. The model allows predictions on the nonlinear relationship of drain source current as well as gate and drain charge with respect to intrinsic voltages over an entire range of operating biases. The neural models have been implemented into a user-defined nonlinear model of a commercial microwave simulator to predict output power performance as well as intermodulation distortion. See "Modeling Power and Intermodulation Behavior of Microwave Transistors with Unified Small-Signal/Large-Signal Neural Network Models," *International Journal of RF and Microwave Computer-Aided Engineering*, July 2003, Vol. 13, No. 4, p. 276.

GFSK Demodulator Serves Low-IF Bluetooth Receivers

SHORT-RANGE COMMUNICATIONS systems such as Bluetooth can benefit from an efficient mixed-mode Gaussian frequency-shift-keying (GFSK) demodulator with frequency offset cancellation circuit. Suitable for low-intermediate-frequency (low-IF) receivers, the demodulator can also be used with continuous-phase-shift-keying (CFSK) receivers. The chip was fabricated in a standard silicon CMOS semiconductor process and draws just 3 mA from a single +3-VDC supply. For more information, see "A GFSK Demodulator for Low-IF Bluetooth Receiver," *IEEE Journal of Solid-State Circuits,* August 2003, Vol. 38, No. 8, p. 1397.

Electromagnetic Bandgap Structures Aid Microstrip Filter Design

ELECTROMAGNETIC-BANDGAP (EBG) structures have proven of interest to optical researchers, although the technology can also be applied to the design of electromagnetic components, such as microstrip filters. Ning Yang and associates from the Institute for Communications Research in Southeast University (Nanjing, China) have explored the use of a compact EBG structure for the fabrication of microstrip bandstop filters. An EBG structure stops the propagation of electromagnetic (EM) waves within a particular band, making them ideal for frequency-selective applications such as filtering. Microstrip bandgap structures are relatively easy to fabricate as part of monolithic circuits. The researchers developed a novel two-layer structure for microwave and RF applications, with modeling performed by traditional EM simulation tools. Using their experimental EBG structure, the researchers fabricated a wideband three-pole Chebyshev-type notch filter centered at 2.1 GHz, with close agreement between actual measured performance and simulated results. The filter yielded a 20-dB stopband of 1.93 to 2.28 GHz (2.1-GHz center frequency) and minimum insertion loss of 50 dB in the stopband. Equivalent-circuit models of the EBG structure and the stopband filter were extracted based on EM simulations and on network-synthesis theory. For more information on the design and characterization of the three-pole EBG microstrip notch filter, see "A Two-Layer Compact Electromagnetic Bandgap (EBG) Structure and Its Applications in Microstrip Filter Design," *Microwave and Optical Technology Letters,* April 5, 2003, Vol. 37, No. 1, p. 62.

Transformer-Feedback CMOS LNA Powers 5-GHz WLANs At +1 VDC

LOW-LOSS TRANSFORMER FEEDBACK is used in a monolithic CMOS low-noise amplifier (LAN) to neutralize the gate-drain overlap of a field-effect transistor and support low-voltage operation. Designed for use in 5-GHz wireless local-area networks (WLANs), the LNA achieves 14.2-dB gain with a noise figure of 0.9 dB at 50 Ω, and a third-order intercept point of +0.9 dBm at 5.75 GHz. The amplifier dissipates 16 mW of power when operating from the +1-VDC supply. Although achieving about the same gain as a cascode design configuration (which is commonly used in 5-GHz WLANs) based on the same semiconductor process, the transformer-feedback LNA features about one-half of the noise figure as the cascode design along with significantly reduced power requirements.The LNA employs an on-chip transformer to realize the feedback function. See "A 1-V Transformer-Feedback Low-Noise Amplifier for 5-GHz Wireless LAN in 0.18-μm CMOS," *IEEE Journal of Solid-State Circuits, IEEE Journal of Solid-State Circuits,* March 2003, Vol. 38, No. 3, p. 427.

Configure An Optimal RF/Microwave Switch System

Modern RF/microwave switching systems can improve the accuracy of production testing, while greatly increasing measurement throughput.

Switching systems are vital parts of automated-test-equipment (ATE) systems for evaluating communications components. Since a typical test system must route a wide range of signals, including RF, microwave, and DC bias signals, to a wide range of instruments (including network and spectrum analyzers and power meters), a switching system must perform reliably, accurately, and efficiently in support of a high-throughput ATE system. Properly configuring an RF/microwave switching system can improve the performance of an ATE system as a whole.

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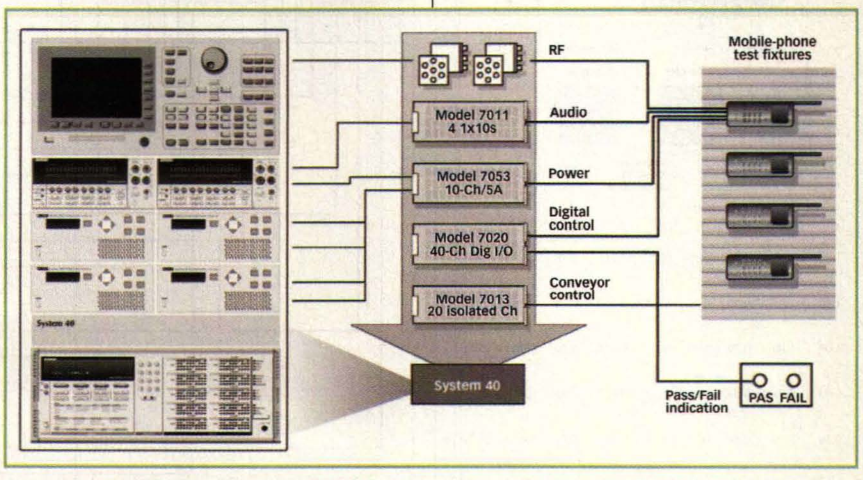
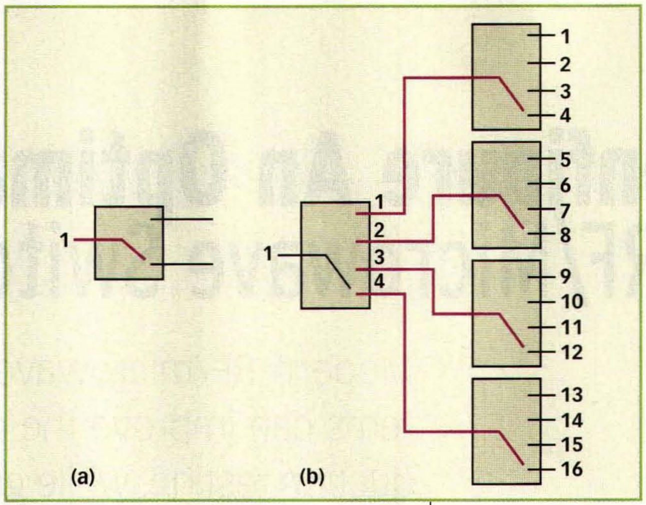
The purpose of an RF/microwave switch is to route signals between measurement instruments and the device under test (DUT). With the help of a switch, an instrument can measure or source multiple DUTs without the need to change cabling for each one. Multiple tests with different instruments can be run on the same DUT or multiple instruments can test multiple DUTs. With the help of a switch system, the test process can also be automated. For example, in the typical lifetime test of **Fig. 1**, the DUT (in this case, a mobile phone) can be stressed at an elevated level for a specified period, then its electrical characteristics can be measured.

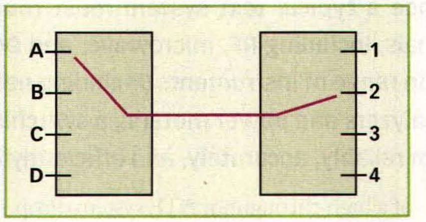


1. In a typical lifetime test, the DUT (in this case, a mobile telephone) can be stressed at an elevated level for a specified period, then its electrical characteristics can be measured.



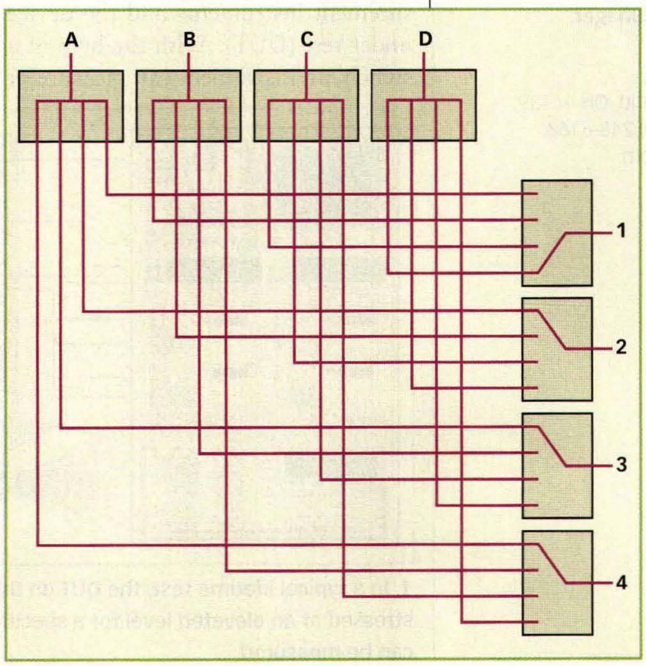
2. A single-pole, double-throw (SPDT) switch can be used to route signals to two different DUTs (a). It can be expanded further into a "multiplexer" configuration, so that a single instrument can be routed to many different DUTs (b).

The DUT can be then stressed even further and the electrical characteristics measured again. Automated switching allows this process to be performed very efficiently.



3. For improved flexibility, a series of switches can be arranged in a blocking matrix to connect multiple instruments to multiple DUTs.

Switch systems can be quite simple or quite elaborate. For example, a single-pole, double-throw (SPDT) switch can be used to route signals to two different DUTs **(Fig. 2a)**. It can be expanded further into a "multiplexer" configuration, so that a single instrument can be routed to many different DUTs **(Fig. 2b)**. As with the SPDT switch, a multiplexer employs a "blocking" arrangement in which only one signal path is active at any time. For improved flexibility, a series of switches can be arranged in a matrix to connect multiple instruments to multiple DUTs (**Fig. 3**). In order to switch any signal to any DUT at any time, a "nonblocking" matrix, like the 4 × 4 matrix of **Fig. 4**,



4. A nonblocking matrix makes it possible to switch any signal to any DUT at any time. While this configuration has the highest flexibility, it is also the most expensive.

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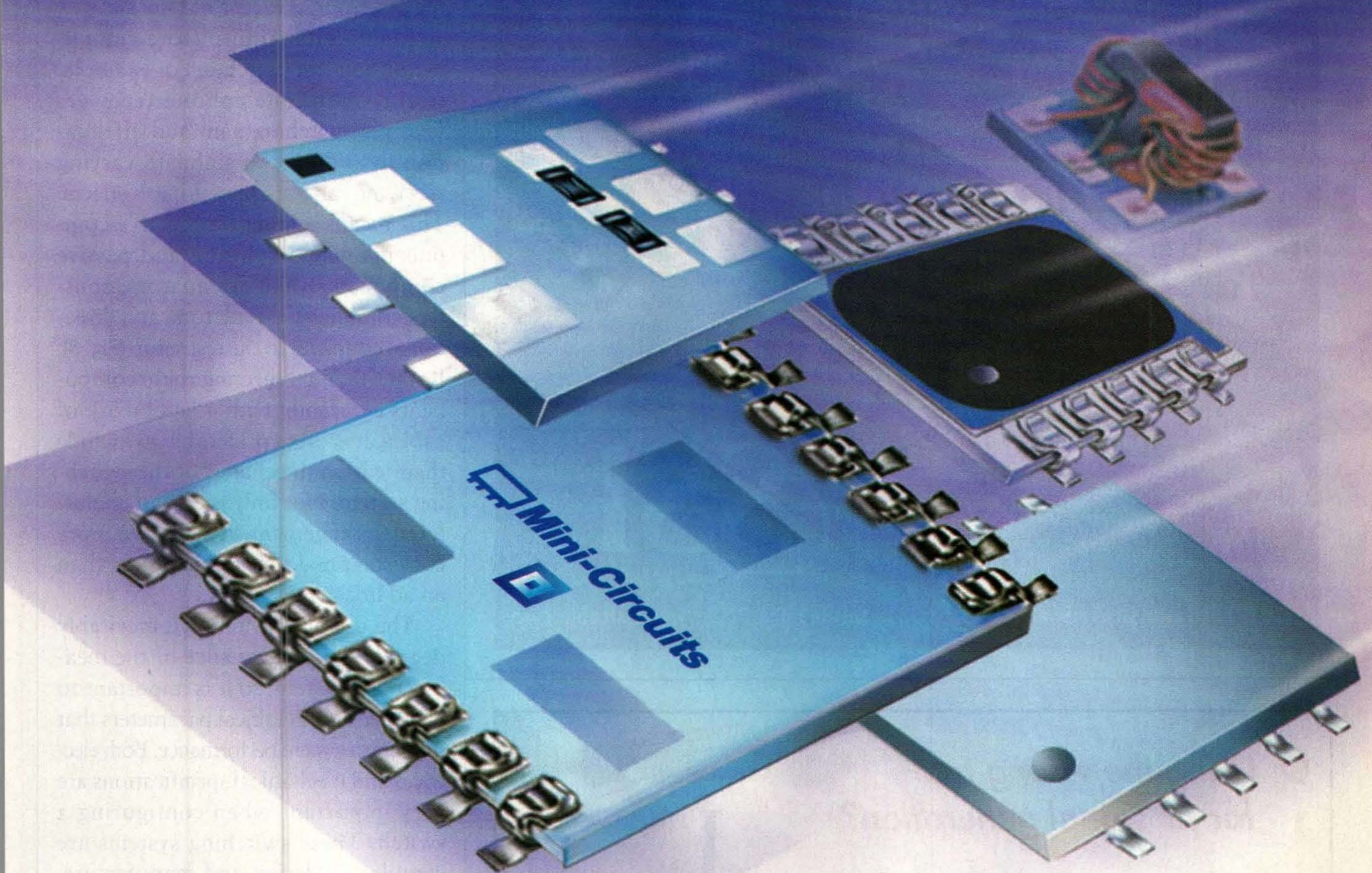

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can be used. While the nonblocking configuration has the highest flexibility, it increases the cost of the switching system by a factor of 5 to 10.

Many tests require more components than just switches. For example, testing mobile-telephone receivers involves switching gain and attenuation in and out, to simulate varying receiving ranges and multipath effects. This means adding both active components, like amplifiers, and passive components, like attenuators, splitters/combiners, circulators, and directional couplers, to the test setup **(Fig. 5)**. Rather than connecting these components externally with a patchwork of cables, it is often preferable to include them within the chassis of the switching system. Not only is this an uncluttered arrangement, it will give more consistent and repeatable results than an ad hoc arrangement.

The use of a switch will inevitably degrade the performance of the measurement system, so it is important to consider several critical parameters that may affect system performance. Both electrical and mechanical specifications are very important when configuring a switch. These switching systems are complex to design and manufacture, so they tend to be significantly more expensive than lower frequency switch systems. During the design phase, the costs and benefits are often weighed against each other to achieve an optimal solution.

Some key specifications that are critical in selecting an RF/microwave switch system include impedance matching, insertion loss, isolation, and VSWR. Since a switch will be positioned between the measurement instruments and the DUT, it is critical to match the impedance levels of all three system elements. For optimal signal transfer, everything in the signal path—the source, the switch, the DUT, and any terminations used—must all have the same impedance. The most commonly used impedance level is 50 Ω, although 75-Ω switching systems (commonly used for cable-television systems) are also available. Impedance mismatches increase VSWR

and can contribute to measurement errors. In high-power systems, they can even lead to equipment damage.

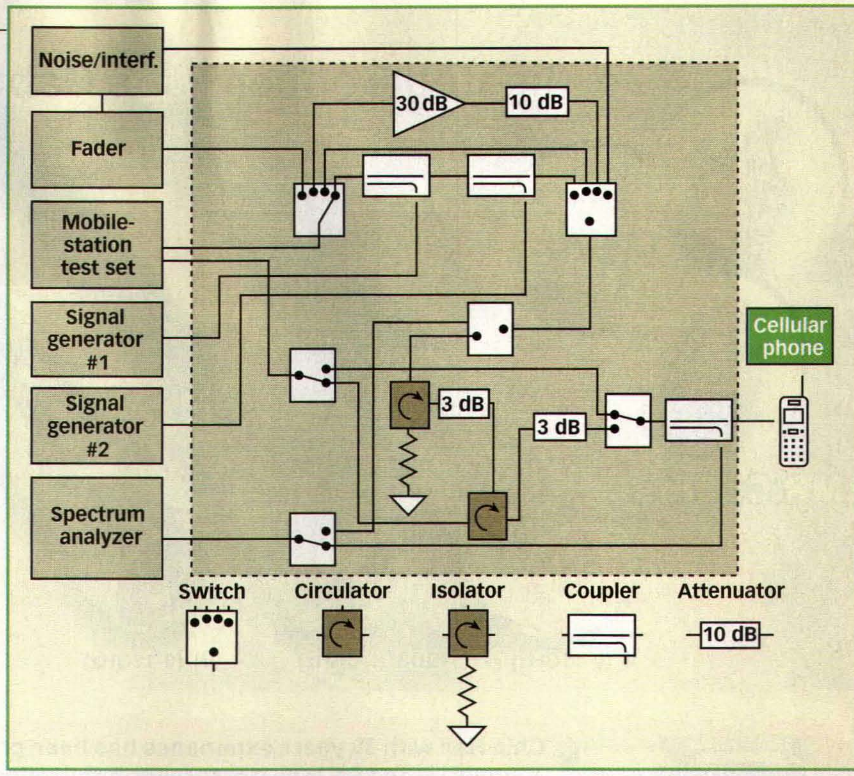
In a system, any passive component added to the signal path will cause some degree of loss. The amount of loss is especially severe at higher frequencies. When signal level is low or noise is high, insertion loss is particularly important. The insertion loss is reflected as a decrease in the available power on the DUT as compared to the test instrument source value. Normally, it is specified as the ratio of output power over the input power in decibels (dB) at a certain frequency or over a frequency range:

$$\text{Insertion loss} = -10\log(P_{out}/P_{in})$$

where:

P_{out} = the output power (in W) and
P_{in} = the input power (in W).

At higher frequencies, signals traveling on different paths can interfere



5. It is often preferable to include active components like amplifiers, and passive components, like attenuators, splitters/combiners, circulators, and directional couplers, within the chassis of the switching system, rather than connecting these components externally via cables.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with each other due to capacitive coupling between the paths or through electromagnetic radiation. Sometimes referred to as "crosstalk," it is especially severe when signal paths are not properly shielded or decoupled from each other. Crosstalk is particularly problematic when a weak signal is physically adjacent to a very strong signal. When maintaining signal-path isolation is critical, additional isolation measures should be used.

Any component added to the high-frequency signal path will not only cause insertion loss, but will also cause an increase in the standing wave in the signal path. This standing wave is formed by the interference of the transmitting electromagnetic wave with the reflected wave. This interference is often the result of mismatched impedances in different parts of the system or connecting points in the system, such as connectors. The voltage-standing-wave ratio (VSWR) is specified as the ratio of the standing wave's highest voltage amplitude to the lowest voltage amplitude in the signal path. It can be calculated as:

$$VSWR = Z_{line}/Z_{load} \text{ or } = Z_{load}/Z_{line},$$

whichever is greater,

where:

Z_{line} = the characteristic impedance of the line and

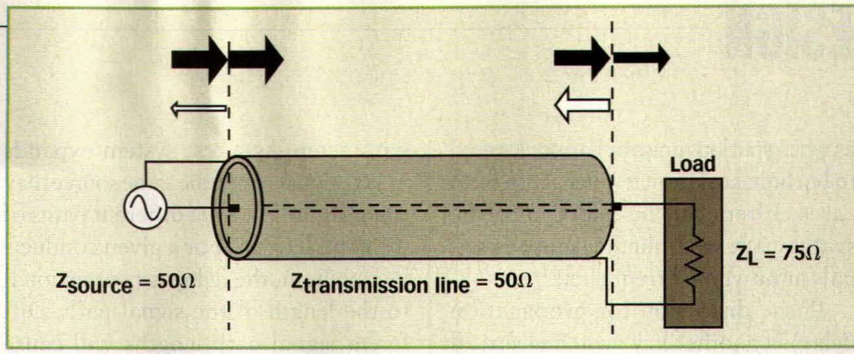
Z_{load} = the characteristic impedance of the load.

VSWR can also be expressed as return loss:

Return loss (dB) = $-20\log[(VSWR - 1)/(VSWR + 1)]$

Figure 6 shows a system with a VSWR of 1.50:1. This is equivalent to a return loss of 14 dB. As a result, with 50 W forward power, reflected power would be 2 W.

Filters connected to switches can be useful in a number of circumstances, such



6. The impedance mismatch between the load and the cable result in a VSWR of 1.50:1, or a return loss of 14 dB. For 50 W forward power, 2 W of power is reflected back to the source.

as when spurious noise or harmonics need to be eliminated from test signals. In these cases, filters can be added into the switch path to eliminate spurious signals at unwanted frequencies.

Phase distortion (or propagation delay) is another key switch electrical parameter. As a test system expands in size, signals from the same source may travel to the DUT via different paths of different lengths. For a given conducting medium, the delay is proportional to the length of the signal path. Different signal-path lengths will cause the signal phase to shift. In digital testing where differential signal testing is key, this phase shift may cause erroneous measurement results. Techniques to ensure the same phase or path electrical length should be used to compensate for such effects.

7. A switching system can be as simple as the model 7999-4 SPDT microwave switch from Keithley Instruments (Cleveland, OH).

Reliability is a major concern when designing a switch system, since ATE system downtime is expensive and unproductive. Typically, an electromechanical switch relay should provide a lifetime of at least one million closures; some electromechanical relays offer rated lifetimes of five million closures or more.

The repeatability of the switch performance is an equally important issue. Repeatability is the measure of the changes in the insertion loss or phase change from repeated use of the switch system. In RF measurement, it is not easy to eliminate the effects from the cycle-to-cycle change in the switch relay closure.

Mechanical specifications should also be considered when specifying a switching system. For example, depending on the application involved, the switch's physical form factor may limit the choice of the switch system. For a small switch, a simple box will do the job. For example, the model 7999-4 microwave switch **(Fig. 7)** from Keithley Instruments (Cleveland, OH) is an RS-232-controllable SPDT switch in a small metal enclosure. For a switch system with a medium number of signal pathways, a system based on the Model 7001 two-slot switch mainframe would be appropriate. For a large-scale switch system, a system based on the company's model 7002 ten-slot mainframe **(Fig. 8)** would be needed.

8. For a large-scale system, a system based on the model 7002 ten-slot mainframe might be required

Many different types of connectors and cables can be used in RF/microwave switch systems. The signal frequency, the system impedance, power rating, and test fixture/handler compatibility, etc. should all be taken into consideration when choosing connectors and cables.

In some cases, status-reporting functions are useful features in switching systems. Switch mainframes that provide a light-emitting-diode (LED) display to indicate the open/closed status of the switch relays are very useful during system setup and troubleshooting.

In addition to electrical and mechanical specifications for an RF/microwave switch system, several factors need to be considered carefully. These factors can easily degrade the system performance even when the best parts are used. For example, most users would like as much switching bandwidth as possible. However, a switching system that can handle 40-GHz signals is more costly than one rated to 18 GHz. If the equipment to be tested involves no frequencies higher than 18 GHz, it is overkill to use a 40-GHz switch. In general, it is more economical to match the bandwidth of the switch to that of the DUT. It is also important to remember that as bandwidth increases the selection of connectors and cables becomes more important, because both attenuation and VSWR tend to increase with frequency. Once again, cost increases with bandwidth.

Another important consideration is the system's ability to transfer the RF power from instrument to DUT. Due to insertion loss, the signal may require amplification. In some applications, it may be necessary to reduce the signal power to the DUT. The use of either an amplifier or attenuator may be needed to ensure that the accurate level of power is transmitted through the switch.

When specifying a switch system, the first step is to consider the system configuration. In order to achieve an optimal, yet cost-effective system, system designers must weigh a variety of electrical and mechanical parameters. Understanding these parameters makes it possible to make informed trade-offs between switch flexibility and system cost. MRF

Mounting Technique Aids MMIC Performance

The bare-die performance of high-frequency MMICs can be retained in millimeter-wave circuits with an innovative "pocket" mounting method.

Performance levels of high-frequency monolithic-microwave integrated circuits (MMICs) are often compromised within packages and circuits. Fortunately, a novel technique for mounting MMICs in microstrip circuits helps optimize device performance even at millimeter wavelengths by eliminating many of the drawbacks of traditional mounting techniques. This patented new approach helps designers achieve MMIC performance promised during wafer probing but often lost in the transition to microwave/millimeter-wave circuitry.

In this new approach, a MMIC is inserted into a laser-drilled pocket in a polytetrafluoroethylene (PTFE) circuit board, establishing continuity with the groundplane and reducing or eliminating jumper wires. A secondary FR4 circuit board is bonded to the bottom of the PTFE board, from which DC control lines are connected to the chip through viaholes. In addition, the MMIC is flush with the top of the board (rather

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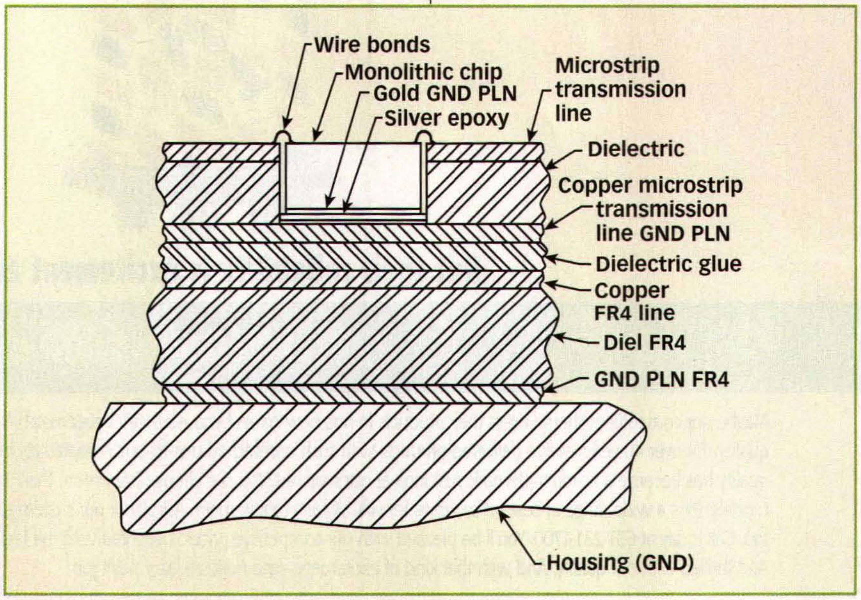
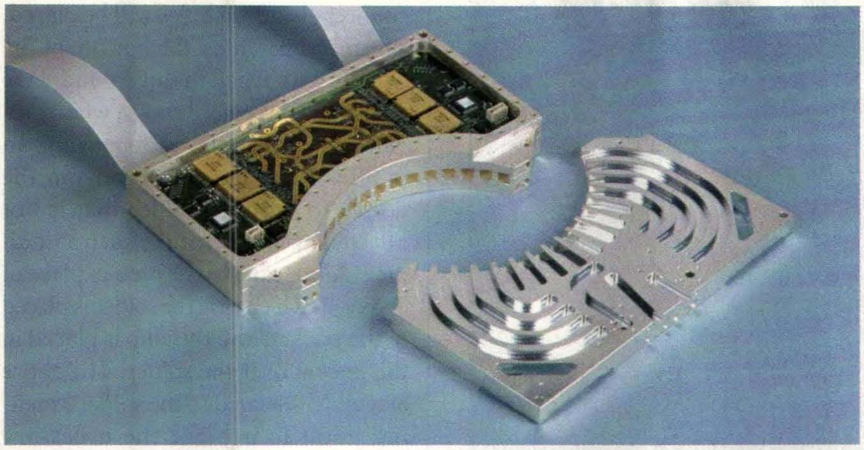


1. This cross-section diagram shows the connections and layers of the pocket-mount assembly approach.



2. MMIC switches and LNAs in this 2 × 16 T/R switch were mounted using the pocket technique.

than on top of it) where it is not subject to damage from handling. Test results indicate that performance of pocket-mounted MMICs differs little from manufacturers' bare-die specifications.

The transition between a MMIC and its supporting microstrip circuit elements and RF and DC connections is the crucial factor in determining its performance when mounted in a circuit. MMIC manufacturers supply copious performance specifications for their die, which in an ideal mounting situation could be perfectly preserved. However, the typical microstrip circuit board onto which a MMIC is bonded presents a less-than-ideal environment, since the path to ground is routed to the chip from the groundplane with via holes. The resulting discontinuities cause significant mismatch, and parasitic capacitance and inductance caused by bond wires are extremely difficult to remove. Consequently, the specified performance of the device can be significantly reduced. The severity of this situation increases with frequency, and becomes a major problem at millimeter wavelengths.

A bare-die MMIC mounted on top of a circuit board is also vulnerable to damage, since it is higher than the surrounding surfaces. This issue can be addressed by incorporating the device in a ball-grid-array (BGA) or low-temperature-cofired-ceramic (LTCC) package, but in addition to being more expensive and difficult to assemble, these packages can increase insertion loss. Faced with a customer requirement for use of bare die to achieve the highest level of performance in a millimeter-wave assembly, KDI Integrated Products (Whippany, NJ) investigated various ways to mount MMICs that would retain their performance, creating a nearly pure resistance between the MMIC and its connections.

> *A bare-die MMIC mounted on top of a circuit board is vulnerable to damage.*

The solution involved creating a pocket for the device in the microstrip laminate just slightly larger than the device itself. This pocket not only provides electrical benefits, but also lowers a 6-mil-thick MMIC to the level of the board, reducing susceptibility to damage. To create the pocket, the top center conductor of the board is removed by laser drilling in the spot where the MMIC will be placed. The drilling continues through the dielectric layer below the center conductor, revealing the main groundplane used by the remainder of the circuit. The surface of the center conductor and groundplane are plasma-etched to remove burned material.

The microstrip and ground lines are then plated with a 0.05-mil layer of gold where the bond wires are to be

connected and via holes will be placed. The metal patch on the bottom of the MMIC is attached to the groundplane with liquid silver-filled epoxy, which provides high mechanical strength and an excellent conductive path from the device to ground. Solder that is not affected by metal plating (such as indium solder), can also be used in place of epoxy, in which case the solder is placed in the pocket, and the chip is placed in the pocket over the solder. The entire assembly is heated to the solder's melting point to achieve the necessary mechanical and electrical bonding of the chip to the groundplane. The bond wires are then connected to the chip and metal-plated areas.

Pocket-mounting allows the groundplane used by the rest of the circuit to become the groundplane for the MMIC as well **(Fig. 1)**. This direct ground connection eliminates the traditional need to provide a ground path to the bottom of the chip from the underlying groundplane through via holes. The discontinuity created by this noncontiguous path degrades circuit performance by creating inductance. This series inductance, when added to the inductance incurred from the RF input and output connections, makes tuning extremely difficult. Tuning of the device when pocket-mounted requires attention only to the wire bonds.

When the MMIC is mounted in the pocket, inductance is minimized from the microstrip ground to the groundplane of the chip. The input port and output port bond wires can also be made extremely short because the chip surface is in the same plane as the microstrip transmission line. By reducing these "four inductances" for any input to any output of a MMIC, the best possible performance can be achieved.

The lines to the MMIC for DC bias and control are accommodated in a convenient way by bonding the bottom of the PTFE board to another board made of FR4. The lines are etched on the FR4 board and are brought up to the top surface alongside of the MMIC with vias. In most applications this eliminates jumpers on the microwave

side of the circuit board, ensuring no disruption of the microwave circuit. If the MMIC requires a bypass capacitor, it can be established on the top surface with vias to the groundplane. A hermetic enclosure can be provided by welding the cover around the housing and using hermetic connectors.

The pocket-mounting technique was used in the fabrication of a 2 × 16 transmit/receive switch used to feed a Rotman or Lunenberg lens antenna array for operation at 28 GHz **(Fig. 2)**. The assembly incorporates a PIN diode switch that connects a transmitter to any of 16 ports and rapidly switches from transmit to receive while maintaining high isolation between the transmitter and receiver. The 16 waveguide input/output ports are placed on an arc to feed or receive signals from the lens, and provide a narrow (8 deg.) 3-dB beamwidth in the transmit mode. In receive mode, the lens directs the signal to one of the 16 waveguide ports.

In the transmit mode, the signal passes through two single-pole, four-throw (SP4T) switches, arriving at the waveguide ports with a loss of about 7 dB. In receive mode, the signal passes through an SP4T switch, through an low-noise amplifier (LNA) with 14 dB gain, and through a second SP4T switch to the receive waveguide output. The receive-path loss is less than 7 dB with gain of 7 dB. All of the MMIC switches and LNAs were mounted in the pocket configuration, which was instrumental in delivering the required performance, while also minimizing the size of the housing. Only three shunt capacitor tuning blocks were required, in contrast to perhaps six that would be needed with a conventional approach.

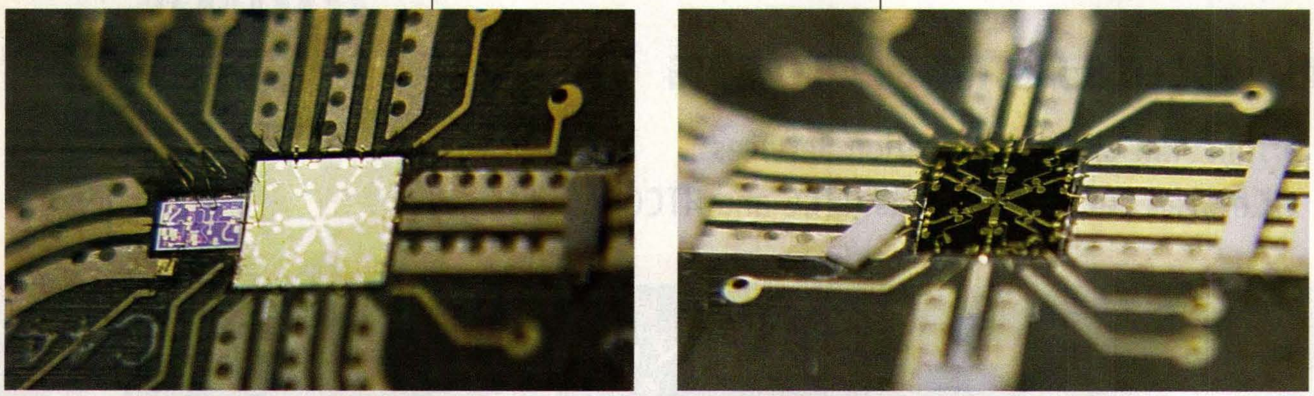
The performance of PIN-diode MMIC switches and gallium-arsenide (GaAs) LNAs mounted in the pocket configuration (**Fig. 3)** was compared with specifications provided by their manufacturers for the bare die measured made on the wafer. Improved performance was noted over the frequency range of 27.35 to 28.35 GHz using the pocket-mounting technique with two MMICs used in the T/R switch.

The electrical characteristics of the transition between an MMIC, its groundplane, and its connections determine how well the device will perform in the circuit.

The UMS CHA-2093, a two-stage LNA, provides a 3-dB noise figure and 14 dB of gain. When the MMIC was mounted on a raised ground plane using via holes to bring up the ground plane from below, considerable input and output tuning was required to achieve a flat gain response. With the chip in a pocket, the performance compared closely with the results obtained by UMS from wafer probing, including the 3 dB noise figure. The CHA-2093 in the pocket was placed very close to a model CP0558-1 six-throw switch from Alpha Industries/Skyworks in the matrix. Minimal and predictable tuning was still necessary between the two monolithic chips (each mounted in its own pocket), because they are not inherently perfectly matched.

The CP 0558-01 delivered insertion loss equal to Alpha's wafer probed results. The device was originally mounted on the plated-through vias and raised ground plane, which produced insertion loss of 2.8 to 3.0 dB. When it was pocket-mounted, the loss improved to 2.2 to 2.4 dB and less tuning was required over the 27.35-to-28.35-GHz range.

In summary, the electrical characteristics of the transition between an MMIC, its groundplane, and its connections determine how well the device will perform in the circuit. Traditional techniques for mounting a die or packaged MMIC on the surface of a microstrip circuit board make it difficult to reduce insertion loss to its lowest level, introduce parasitic capacitance and inductance, and place the device in the open where it is subject to damage in handling. In addition, the large number of jumpers needed to make connections to the chip might be impossible to accommodate in some space-critical applications.



3. This close-up shows the close proximity of the switch and LNA MMICs in the pocket-mount assembly (left). The large chip is the flush-mounted six-way switch (right), which has one shunt PIN diode in each of the six legs of the star. The input port can be any leg and the output can be any other leg. There is no common arm. The pieces of white material are alumina, placed between the microstrip line and ground, and used as a tuning technique.


CLOCK
TRANSLATOR
INPUT FREQ. SELECT A B C EXAMPLE
f1 = 0 0 0 8 KHz
f2 = 0 0 1 64 KHz
f3 = 0 1 0 1.544 MHz
f4 = 0 1 1 2.048 MHz
f5 = 1 0 0 19.44 MHz
f6 = 1 0 1 44.736 MHz
f7 = 1 1 0 51.84 MHz
f8 = 1 1 1 155.52 MHz
SMC CTM-8-OC48 0230
622.08 MHZ OR 1244.16 MHZ OR 2488.32 MHZ
• Exceptional Phase Noise (Low Jitter)
• Superb Immunity To Microphonics
• Tuning Linearity <2:1
• Suitable For Automated Assembly
• Well Suited For LMDS, SONET, Digital Radio With Higher Order QAM Applications
SMC VCSO-OC48 0232
SMC CTS-C3-48 0228
SMC VCSO-OC12 0232
CTS-C1-12 0228
@622 MHz
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The pocket-mounting technique eliminates these drawbacks, and without significant increase in cost delivers essentially the same MMIC performance in-circuit as when measured on the wafer. The technique can be used with any type of MMIC, or even transistors, and is not limited to applications in the millimeter-wave region. However, since the MMIC interconnect transition becomes even more critical at higher frequencies, the pocket-mounting technique can provide its greatest benefits in these applications. MRF

Simulation Approach Aids RF Design Debugging

A single software tool performs all the analysis and synthesis functions needed to check RF design architectures and save valuable design cycles.

Design time can be dramatically shaved with the help of a new simulation technique that enables RF designers to perform root-cause analysis of RF architectures. The approach provides complete spectrum identification and origination information for each design, and allows arbitrary topologies and multiple signal paths to be explored. Based on a single software tool, continuous verification from the RF architec-ture phase through the measured data phase can now be performed.

When developing an RF architecture, an engineer determines the type, number, and order of stages needed to meet a set of requirements. Spreadsheets such as Microsoft Excel have typically been used for this design task, but the approach is inexact and can lead to a poor RF architecture which will then present problems and lead to long product-development cycles. Design cycles typically occur when the basic RF architecture must be modified, or because an electromagnetic (EM) analysis has

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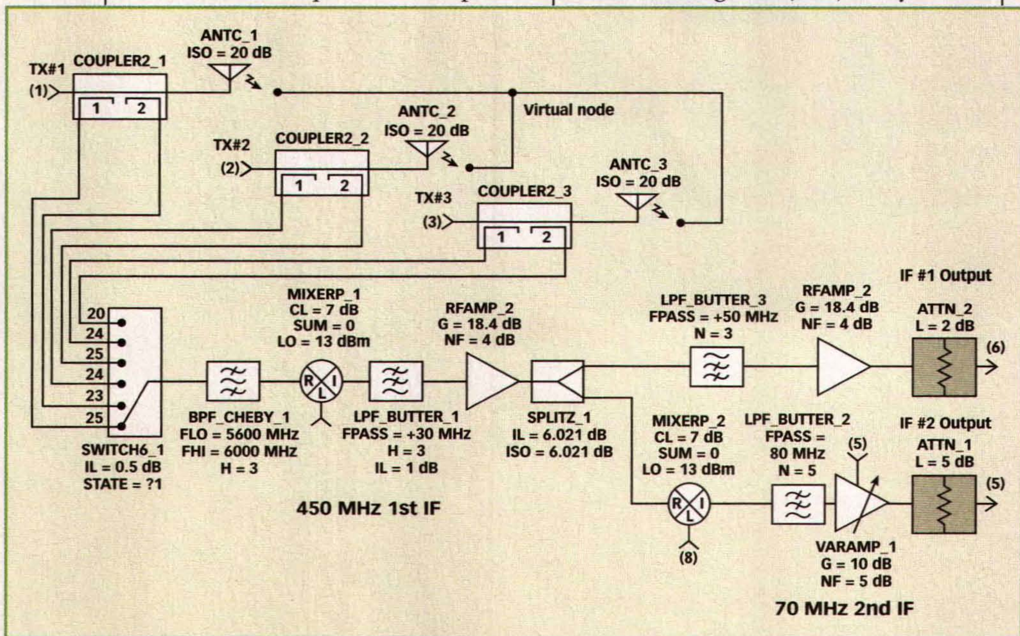

1. This block diagram shows a three-sector 5.8-GHz power/VSWR tester.

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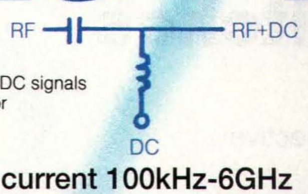

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	F_L-F_U	L	M	U	L	M	U	U	1-9 qty.
▲ZFBT-4R2G	10-4200	0.15	0.6	0.6	32	40	50	1.13:1	59.95
▲ZFBT-6G	10-6000	0.15	0.6	1.0	32	40	30	1.13:1	79.95
▲ZFBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	50	1.13:1	79.95
▲ZFBT-6GW	0.1-6000	0.15	0.6	1.0	25	40	30	1.13:1	89.95
▲ZFBT-4R2G-FT	10-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	59.95
▲ZFBT-6G-FT	10-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-4R2GW-FT	0.1-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-6GW-FT	0.1-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	89.95
★ZNBT-60-1W	2.5-6000	0.2	0.6	1.6	75	45	35	1.35:1	82.95
■PBTC-1G	10-1000	0.15	0.3	0.3	27	33	30	1.10:1	25.95
■PBTC-3G	10-3000	0.15	0.3	1.0	27	30	35	1.60:1	35.95
■PBTC-1GW	0.1-1000	0.15	0.3	0.3	25	33	30	1.10:1	35.95
■PBTC-3GW	0.1-3000	0.15	0.3	1.0	25	30	35	1.60:1	46.95
•JEBT-4R2G	10-4200	0.15	0.6	0.6	32	40	40	-	39.95
•JEBT-6G	10-6000	0.15	0.7	1.3	32	40	40	-	59.95
•JEBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	40	-	59.95
•JEBT-6GW	0.1-6000	0.15	0.7	1.3	25	40	30	-	69.95

L = Low Range M = Mid Range U = Upper Range

NOTE: Isolation dB applies to DC to (RF) and DC to (RF+DC) ports.
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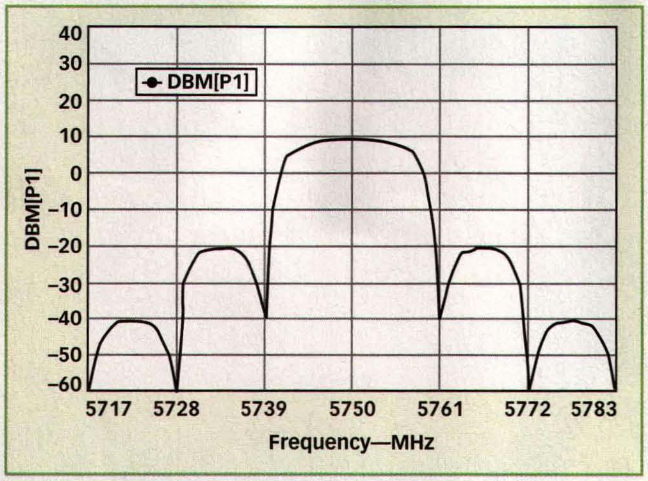
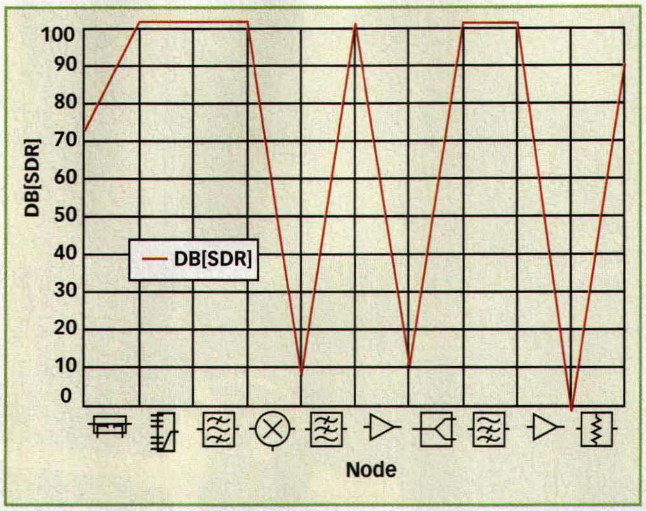


2. This plot represents the spectral power of the WLAN modulation source fed to the design of Fig. 1.



3. In the high-power simulation, the dynamic range is examined between the total node power and the amplifier output power at 1-dB compression.

uncovered unwanted field effects. Although design cycles due to EM problems are sometimes unavoidable (or at least unforeseen), design cycles due to poor RF architectures can be virtually eliminated with this new simulation technique.

An effective software tool for RF architecture analysis should at the least:

• Provide RF root cause analysis;

• Perform design verification at every step in the design process (users should be able to substitute designed and measured circuits into the architecture);

• Provide channel measurements at any frequency;

• Analyze channel measurements along arbitrary paths;

• Analyze “sneak” or leakage paths;
• Account for nonlinear behavior;
• Simulate broadband noise;
• Provide architectural optimization; and
• Simulate conducted emissions.

These features are part of a new simulation technique implemented in the SPECTRASYS module of the GENESYS suite of RF design software tools from Eagleware Corp. (Norcross, GA).

An example may help to illustrate how effective RF architecture analysis can save design time, using a three-sector 5.8-GHz wireless-local-area-network (WLAN) VSWR/power tester (**Fig. 1**). In this design, a switchable receiver measures forward and reflected power for each of three antennas. The impedance of each antenna has been defined in terms of return loss. The first intermediate frequency (IF) is 450 MHz with no automatic-gain-control (AGC) stage. Consequently, this output can be used for actual power measurements. The second IF is at 70 MHz and has AGC. The second IF can be used as a demodulated output.

> ***When developing an RF architecture, an engineer determines the type, number, and order of stages needed to meet a set of requirements.***

Figure 2 shows a WLAN modulation source applied to each antenna through a coupler. A virtual node has been created between antennas to represent antenna-to-antenna isolation. In this example, the dynamic range of the WLAN input signal is assumed to be between +10 and +30 dBm. This tester must accurately measure VSWR across this dynamic range for both the forward and reflected power.

The high-power case occurs when looking at the forward power of +30 dBm. **Figure 3** is a level diagram showing the total node power compared with the 1-dB compression point for each node, indicating that the last amplifier is in compression (the schematic symbol also changes color indicating an error). The graph makes helps to identify all of the weak links in this headroom chain.

The low-power case occurs when looking at the reflected power at the input power of +10 dBm. **Figure 4** shows a level diagram showing the total power at the node compared to the power in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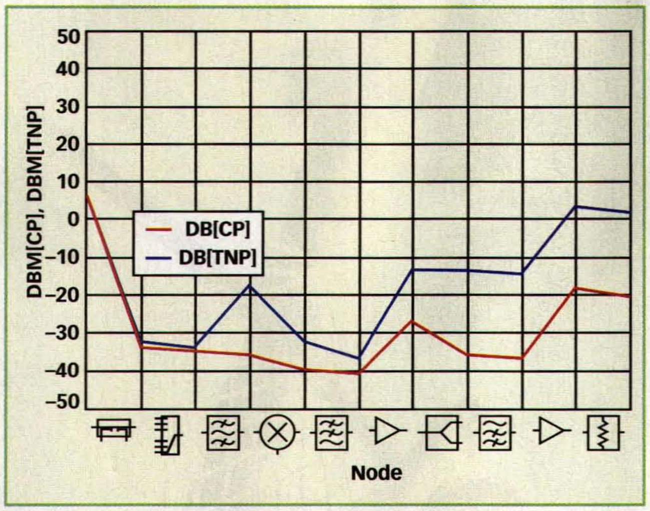
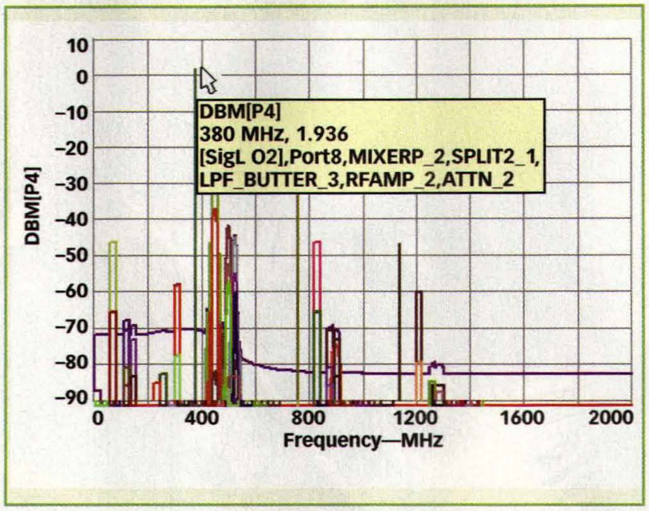


4. By simulating the total power at the first IF node compared to the power in a 22-MHz WLAN channel, potential problems can be found with the design of Fig. 1.



5. By examining the spectrum of the first IF output port, offending signals can be identified.

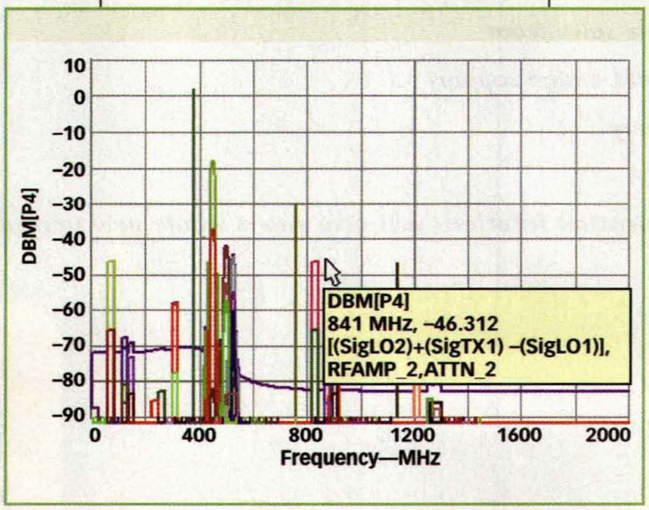
a 22-MHz WLAN channel. By examining the total power at that point (the anticipated channel power), rather than with a power meter placed at the output port, a problem signal becomes apparent.

Once a problem is known, the next step is finding the root cause of the problem. By checking the first IF output spectrum in **Fig. 5**, the offending signal can be identified at a frequency of 380 MHz, power level of +1.936 dBm, equation of [SigLO2] (which is the name of the second LO source), a creating element of "Port8," and a traveled path to the viewing node. The root cause of the problem is the second LO signal leaking into the output of the first IF section.

Figure 6 shows another identification example, in which a second-order intermodulation product is generated in "RFAMP_2" between the second LO ("SigLO2") and the difference IF output ("SigTX1 – SigLO1"). By identifying additional spectrum, another root problem with this RF architecture becomes apparent: intermodulation generate in the first IF amplifier ("RFAMP_2") by the 450-MHz IF signal and the second LO signal.

The best solution to this problem can be found by taking a close look at the path of the offending signal **(Fig. 7)**. Corrective actions include reducing the LO drive to the second mixer, improving the LO-to-RF isolation of the second mixer, inserting a filter between the second mixer and splitter, improving the port-to-port isolation of the splitter, or using a bandpass filter instead of a lowpass filter in the first IF. Traditional analysis would not isolate this problem; it could only be found during laboratory tests of prototype hardware, thus requiring another design cycle.

Using the SPECTRASYS module of GENESYS, a designer can directly invoke synthesis tools and design the subcircuits directly from the behavioral model. The "corrective" bandpass filter, for example, can be synthesized using GENESYS's FILTER module, with the synthesized circuit automatically substituted back into the RF architecture. The system simulation will then use this new circuit implementation for that stage of the RF architecture, rather than the behavioral model. Test or EM data for each component can easily be used in place of the behavior model by simply bringing up the component parameters and selecting the EM simulation or appropriate data file. This process of moving between behavioral, circuit, EM, and measured data enables continuous design verification, beginning with RF architecture all the way through measured data.

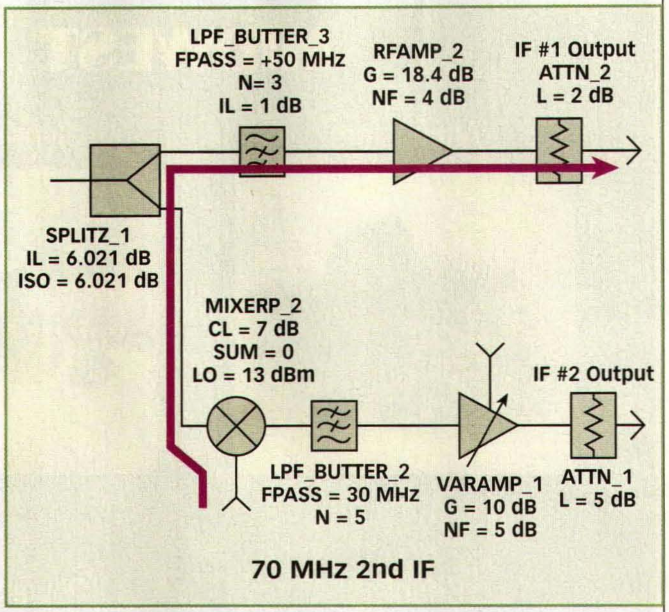


6. By performing identification of intermodulation signals, the root cause of the distortion can be found.

Accurate Models

Accurate models are important in any type of simulator. One of the major factors in producing a good RF architecture tool is the ability to simulate conducted emissions (for regulatory requirements such as those established by the FCC and ETSI). Traditional simulators make unilateral

assumptions for system models and signals only flow in a single direction. The new simulation technique is based on bilateral models, which provide a more accurate prediction of conducted emissions. For example, a traditional simulator will assume that $S_{12} = 0$ for a system-level RF amplifier model to represent a case of perfect isolation, but such a condition cannot be used to accurately simulate conducted emissions since an LO signal would never leak backward through the LNA and appear at the antenna. The bilateral approach allows for this leakage and consequently allows for a more accurate simulation of the leakage paths.



7. This closeup view of the 70-MHz second IF section shows the root source of the offending signals (second LO signals leaking back into the first IF).

Since a number of components within a wireless design exhibit nonlinear behavior under certain conditions, traditional linear simulation falls short for RF architectural analysis. Harmonic-balance techniques are effective for nonlinear circuit simulation, but are limited because of their use of discrete (rather than continuous or swept) frequencies, lack of signal bandwidth, and lack of continuous noise or channel concept. Furthermore, convergence and the slow simulation speeds of harmonic-balance simulators can limit their usefulness. Simulating more than a handful of carriers can quickly become time consuming.

Time Simulations

Discrete time simulations are well suited for digital-signal-processing (DSP) design, although such simulations are based on narrowband assumptions when applied to RF design. This assumption ignores all of the spurious effects the designer is trying to identify and characterize. For example, an unwieldy number of simulation points are necessary to examine a 30-kHz signal on a 5-GHz carrier, not to mention the number of simulation points needed to examine the carrier's harmonics. In a discrete time simulation, the simulation time increases as the resolution is improved and/or the simulation frequency is increased. Furthermore, discrete time models typically contain no input and output impedance information, so VSWR cannot be included as part of a simulation. Having dedicated input and output ports also becomes a problem, because signals cannot travel backward through these models.

The new simulation approach provides the opportunity to model nonlinear behavior, but in a timely fashion. The approach provides RF architecture debugging and continuous design verification. It delivers complete spectrum identification and origination information for every spectrum., and accounts for VSW, leakage paths, broadband noise, and nonlinearities. For more information on the approach, including design examples in video form, visit the Eagleware website at www.eagleware.com. MRF

Measure Power Accurately With A Spectrum Analyzer

POWER MEASUREMENTS OF MODULATED carriers at high frequencies usually involve a calibrated power meter with adequate bandwidth and careful techniques to ensure reliable results. It is also possible to accurately measure the power levels of high-frequency modulated signals with a properly equipped spectrum analyzer and some proven test techniques. An application note from Aeroflex, "Accurate power measurements using spectrum analyzers," describes the approach. The company offers a line of spectrum analyzers with models operating from 9 kHz to 3 GHz, 13 GHz, and 26.5 GHz.

The three-page note, written by Jean Noel Payen and Jean Jacques Perret, provides information for measuring the power or noise level relative to a given reference level, the adjacent-channel power (by measuring the difference between the power levels within a channel and in adjacent channels), the occupied bandwidth (by measuring the system bandwidth for a given percent of the total channel power), and the harmonic distortion.

The power measurements are performed by integrating several elementary power samples taken at different frequencies over the resolution bandwidth of the spectrum analyzer's resolution-bandwidth filter. It is assumed that the equivalent noise bandwidth of each analyzer's filter is fairly close to the filter's resolution bandwidth; the samples help to identify any deviations. The samples are taken at frequency intervals equal to the equivalent noise bandwidth of the filter in use. Since the integration bandwidth does not exactly match the entire number of equivalent noise bandwidths for a given set of measurements, the integration bandwidth must be higher than the equivalent noise bandwidth in order to limit the uncertainty of the equivalent noise bandwidth estimations.

The note provides an example with integration bandwidth of 20 MHz and resolution bandwidth of 100 kHz. The note also correction factors and a comparison of results to those of a power meter. Copies of the note are available for free download from the company's website.

Aeroflex, 35 South Service Rd., Plainview, NY 11803; (516) 694-6700, (800) 843-1553, FAX: (516) 694-4823, Internet: www.aeroflex.com.

It is also possible to accurately measure the power levels of high-frequency modulated signals with a properly equipped spectrum analyzer and some proven test techniques.

Dual Logamps Deliver Gain And Phase Information To 2.5 GHz

GAIN AND PHASE MEASUREMENTS are critical to the operation of many commercial and military systems. Fortunately, an application note from Analog Devices (Norwood, MA) describes how to use the company's model AD8302 RF integrated circuit (RF IC) to make accurate gain and phase measurements from audio frequencies to 2.5 GHz. Written by John Cowles and Barrie Gilbert, the application note first appeared in the company's "Analog Dialogue" newsletter and is now available for download from the Analog Devices website or contained on an RF IC product reference CD-ROM.

The AD8302 integrates two identical logarithmic amplifiers in monolithic form, each capable of measuring signals over a 60-dB dynamic range. Both of the logamps are traceable to a bandgap reference. The IC also includes a high-frequency phase detector for simultaneous measurement of phase. So, not only can the device measure amplitude, it can also measure the phase difference between two signals. Each of the logamps generates a hard-limited output at its final stage.

The note features example phase measurements at 900, 1900, and 2200 MHz. The device shows accurate results due to the careful balance between its two highly integrated logamps. The note offers several signal/bias connection configurations for using the AD8302 for performing absolute power measurements using an AC reference as well as for monitoring the frequency response of an amplifier under test and reporting the gain levels. The device can also monitor the reflection coefficient of a load (an example is given for a PIN diode with impedance modified by bias) and also serve as a gain and phase comparator with controllable threshold levels.

The note includes instructional graphics and samples of expected measurement results. For a free copy of the article, visit the company's website.

Analog Devices, Inc., 3 Technology Way, Norwood, MA 02062; (781) 329-4700, (800) ANALOGD, FAX: (781) 326-8703, Internet: www.analog.com.

cover story

MEMS Sources Offer Alternative To Quartz

Micromachining techniques have delivered resonators and reference oscillators that are a fraction of the size of conventional ceramic and quartz-crystal clock oscillators.

JACK BROWNE
Publisher/Editor

Frequency generation has long relied on the quartz-crystal resonator as a timekeeper. Because of the required wavelengths (for typical frequencies of 10 and 20 MHz), however, quartz resonators cannot be miniaturized beyond about 1 or 2 mm on a side. In contrast, microresonators based on microelectromechanical-systems (MEMS) technology promise the spectral performance of quartz crystal in a fraction of the size. Starting with a resonator beam size of 30 × 8 μm, the 19.2-MHz MRO-100 micro-oscillator from start-up Discera (Campbell, CA) can be fabricated as part of a miniature monolithic multiband wireless transceiver solution. For evaluation purposes, the miniature sources are supplied in standard 3 × 3-mm and 4 × 4-mm chip-scale packages.

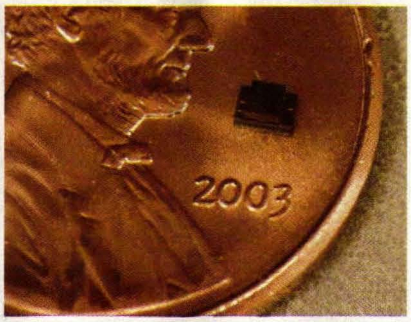
Discera, still relatively unknown outside of their customer base, made waves at the recent Microwave Theory & Techniques Symposium (Philadelphia, PA, June 8-13, 2003) with prototype results for their MRO-100. The company, founded in 2001 by Dr. Clark T.-C. Nguyen, a Professor of Electrical Engineering from the University of Michigan, and Rick Snyder, CEO of Ardesta LLC, is financed by means of seed funding from Ardesta.

The company is currently sampling the MEMS-based micro-oscillators **(Fig. 1)** to a number of companies involved in wireless communications. Discera's resonators and oscillators are fabricated as micromachined mechan-

ical structures, with resonant beams that actually exhibit microvibrations at precise frequencies. And since these sources can be produced at a fraction of the size of traditional quartz-crystal or surface-acoustic-wave (SAW) oscillators, wireless handset manufacturers currently employing multiple-stage receiver architectures are interested in the potential of a tiny, tri-band MEMS oscillator.

The one "fly in the ointment" for this technology, however, is that the vibrating elements within the MEMS microresonators and micro-oscillators have such low mass. As a result, they must be isolated at certain frequencies from air molecules, thus requiring a package capable of maintaining a fairly low-vacuum environment. Similarly, the package must be hermetic to isolate any contamination, such as water molecules, from the low-mass resonant structures. In spite of the low mass of these structures, however, they are rugged enough to withstand even the shock and vibration endured by most cellular telephones.

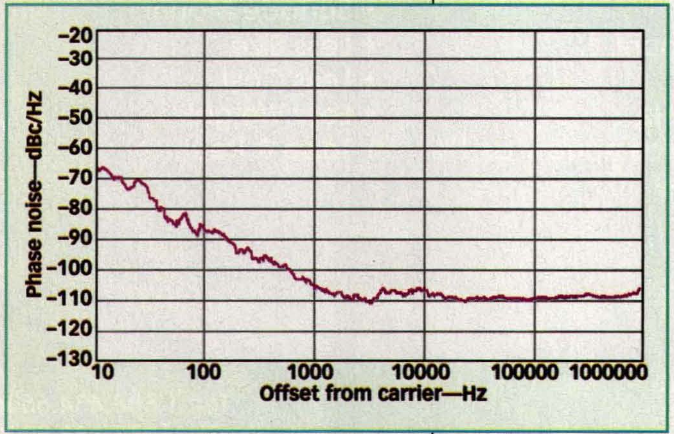
Resonators, of course, are building blocks for RF architectures, and can be used for a number of different components, including filters, oscillators, and switches. At present, the company is achieving resonators with quality factors (Q's) of 10,000 at 20 MHz, based on a prototype fabrication process. According to Discera's CEO Didier Lacroix, the Q's should easily surpass 20,000 at 20 MHz once the firm makes the transition to a higher-volume production MEMS process. Compare these values to Q's of about 20 for an integrated-circuit (IC) filter and about 2000 for a SAW resonator.



1. A packaged MRO-100 micro-oscillator is almost lost on the face of a US penny.

Because they are so small, a bank of the miniature resonators can be fabricated onto a single die to produce a chip-scale switch/filter bank. Discera's micro-oscillators are based on polysilicon resonators fabricated with a standard silicon MEMS/semiconductor process, allowing integration with monolithic active and passive components.

The company's current batch of MRO-100 micro-oscillators are designed for +2.5-VDC operation—a considerably lower operating voltage than commercial MEMS components previously announced from other suppliers. During measurements, a 3 × 3-mm surface-mount-packaged 19.2-MHz oscillator with +2.45-V internal regulated supply was mounted on an oscillator test board and powered by a +3-VDC 20-mm coin-cell battery (with 220 mAh rating). Current draw was just 2.7 mA in this discrete implementation, although it is expected that a more integrated oscillator would operate with considerably less current. Output signals were AC coupled from the test board at an amplitude of 650 mV peak to peak. The measured output power at 50 Ω was –10.5 dBm. The measured phase noise was –106 dBc/Hz offset 1 kHz from the carrier, reaching a noise floor of –110 dBc/Hz **(Fig. 2)**.



2. The measured phase noise for a 19.2-MHz surface-mount micro-oscillator mounted on an oscillator test board is –106 dBc/Hz offset 1 kHz from the carrier.

According to Lacroix, the current prototype process achieves critical dimensions of 1 μm. With improvements in lithography expected with the shift to a larger-scale production process, stability and phase noise should improve dramatically. The resonator/oscillator design included mechanical temperature compensation—allowing for structural expansion and contraction with increases and decreases in temperature, respectively. The mechanical temperature compensation, which support stable frequency performance over a wide temperature range of –40 to +150°C, eliminates the need for power-inefficient thermistor- or oven-based temperature compensation.

In addition to their benefits of small size and low power, the MEMS-based MRO-100 micro-oscillators feature versatile modulation capability, tuning by means of applied voltage. Capable of tuning from the center frequency by as much as 1000 PPM/V, a tuning voltage can be used to set the final operating frequency, make adjustments to a reference frequency, or introduce modulation on the reference source (with setting time of less than 1 ms). The MEMS-based micro-resonators can also be modulated on and off, allowing them to double as RF switch elements within more complex switched filters.

The company is currently exploring packaging options for its RF MEMS devices. Discera offers its technology as packaged, discrete devices, but will also license its patented microresonator technology to other companies, such as IC developers, interested in incorporating miniature reference oscillators in their designs. **Discera, Inc., 51 East Campbell Ave., Suite 102, Campbell, CA 95008; (408) 376-4150, FAX: (408) 376-4151, e-mail: info@discera.com, Internet: www.discera.com.** MRF

Testers Mimic Propagation Losses To 13.25 GHz

This family of attenuator- and coupler-based microwave path simulators can introduce controlled amounts of signal loss to emulate the conditions in communications links.

JACK BROWNE
Publisher/Editor

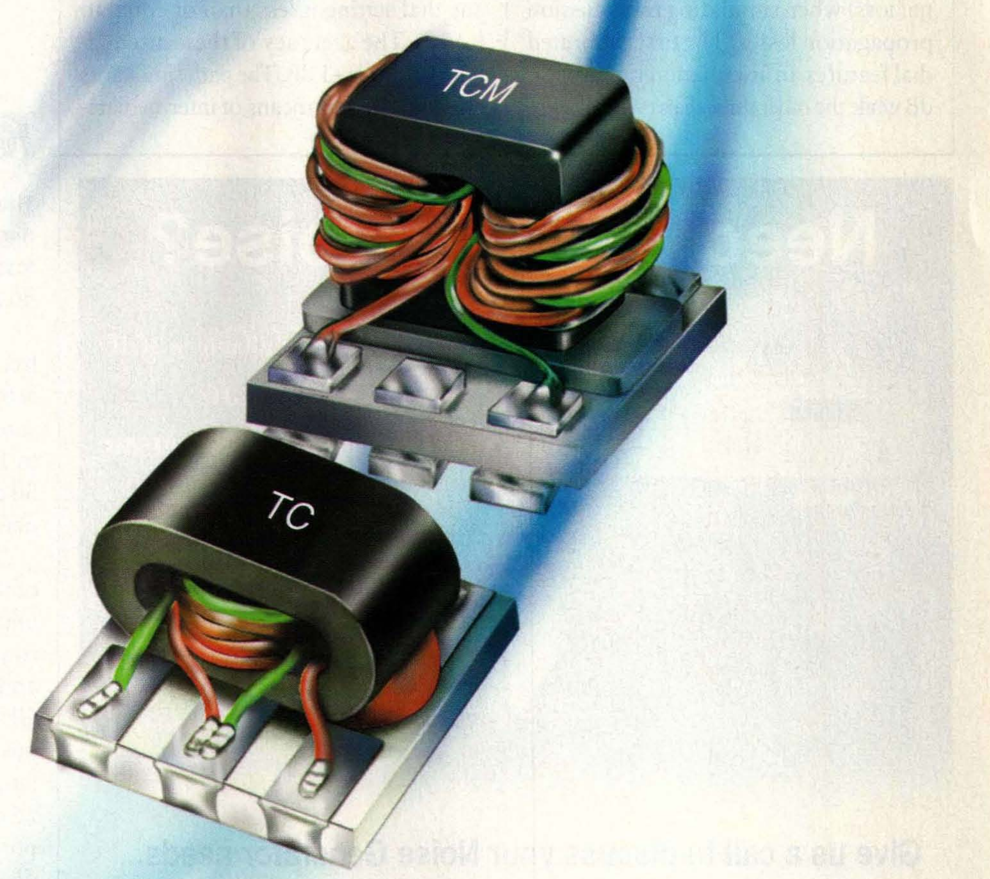
Signal losses and fading in communication links result from atmospheric losses, reflections from terrain, and multipath distortion. To recreate the effects of those signal losses, ARRA, Inc. (Bay Shore, NY) offers their model AR39XX and AR40XX series of Microwave Path Simulators for evaluating communications equipment and components from 1.7 to 13.25 GHz in bands. Based on a combination of precision variable attenuators and couplers, the path simulators allow users to dial in as little or as much signal attenuation as needed to find such parameters as system sensitivity and threshold points where bit-error-rate (BER) performance is degraded. The path simulators typically offer a minimum dynamic attenuation range of 100, and achieve total attenuation to a maximum of 140 dB when all dials are set at maximum.

One example of the product line is the AR3987-1, an eight-port path simulator that operates from 10.70 to 13.25 GHz **(see figure)**. Six- and four-port versions are also available. The rack-mountable unit features an attenuation range of 0 to 100 dB (as much as 140-dB attenuation considering total losses through the simulator). The simulator leverages the company's expertise in attenuator technology to provide low VSWR at all direct and coupled ports. The VSWR at ports A, B, and C, for example, is less than 1.15:1. The VSWR at coupled ports M and M′ is less than 1.80:1.

The path simulators at a glance

Model	Frequency range (GHz)	Ports
AR4027-1	1.700 to 2.300	Four
AR3945-1	3.700 to 4.200	Four
AR3945-2	5.850 to 6.425	Four
AR3945-3	6.425 to 6.875	Four
AR3945-4	7.100 to 8.500	Four
AR3971-1	3.700 to 4.200	Six
AR3971-2	5.850 to 6.425	Six
AR3971-3	6.425 to 6.875	Six
AR3971-4	7.100 to 8.500	Six
AR3986-1	10.70 to 13.25	Six
AR3972-1	3.700 to 4.200	Eight
AR3972-2	5.850 to 6.425	Eight
AR3972-3	6.425 to 6.875	Eight
AR3972-4	7.100 to 8.500	Eight
AR3987-1	10.70 to 13.25	Eight

RF TRANSFORMERS



.3-2500MHz as low as 99¢ each (qty. 100)

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LEADLESS Ceramic Base

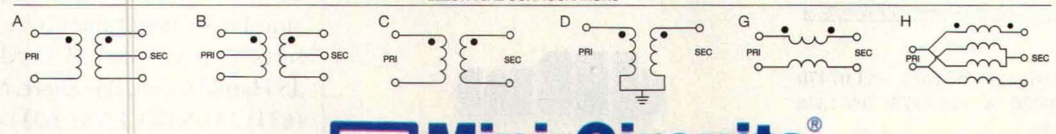
(actual size) MODEL	Ω Ratio & Config.	Freq. (MHz)	Ins. Loss❖ 1dB (MHz)	Price $ea. (qty. 100)
TC1-1T	1A	0.4-500	1-100	1.19
TC1-1	1C	1.5-500	5-350	1.19
TC1-15	1C	800-1500	800-1500	1.29
TC1.5-1	1.5D	.5-2200	2-1100	1.59
TC2-1T	2A	3-300	3-300	1.29
TC3-1T	3A	5-300	5-300	1.29
TC4-1T	4A	.5-300	1.5-100	1.19
TC4-1W	4A	3-800	10-100	1.19
TC4-14	4A	200-1400	800-1100	1.29
TC8-1	8A	2-500	10-100	1.19
TC9-1	9A	2-200	5-40	1.29
TC16-1T	16A	20-300	50-150	1.59
TC4-11	50/12.5D	2-1100	5-700	1.59
TC9-1-75	75/8D	0.3-475	0.9-370	1.59

LEADS Plastic Base

(actual size) MODEL	Ω Ratio & Config.	Freq. (MHz)	Ins. Loss❖ 1dB (MHz)	Price $ea. (qty. 100)
TCM1-1	1C	1.5-500	5-350	.99
TCML1-11	1G	600-1100	700-1000	1.09
TCML1-19	1G	800-1900	900-1400	1.09
TCM2-1T	2A	3-300	3-300	1.09
TCM3-1T	3A	2-500	5-300	1.09
TTCM4-4	4B	0.5-400	5-100	1.29
TCM4-1W	4A	3-800	10-100	.99
TCM4-6T	4A	1.5-600	3-350	1.19
TCM4-14	4A	200-1400	800-1000	1.09
TCM4-19	4H	10-1900	30-700	1.09
TCM4-25	4H	500-2500	750-1200	1.09
TCM8-1	8A	2-500	10-100	.99
TCM9-1	9A	2-280	5-100	1.19

Dimensions (LxW): TC .15" x .15" TCM .15" x .16" ❖Referenced to midband loss.

ELECTRICAL CONFIGURATIONS



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377 Rev. B

The simulator provides three calibrated dials and one uncalibrated dial to control the amount of attenuation (signal loss) when simulating transmission propagation losses. The first calibrated dial features an attenuation range of 80 dB while the other three dials control attenuation ranges of 20 dB each. The resolution for any dial setting is less than or equal to 1 dB, while the resettability at any dial setting is less than or equal to 0.5 dB. The accuracy of these attenuation settings is ±1 dB. The path simulators are calibrated by means of intermediate-

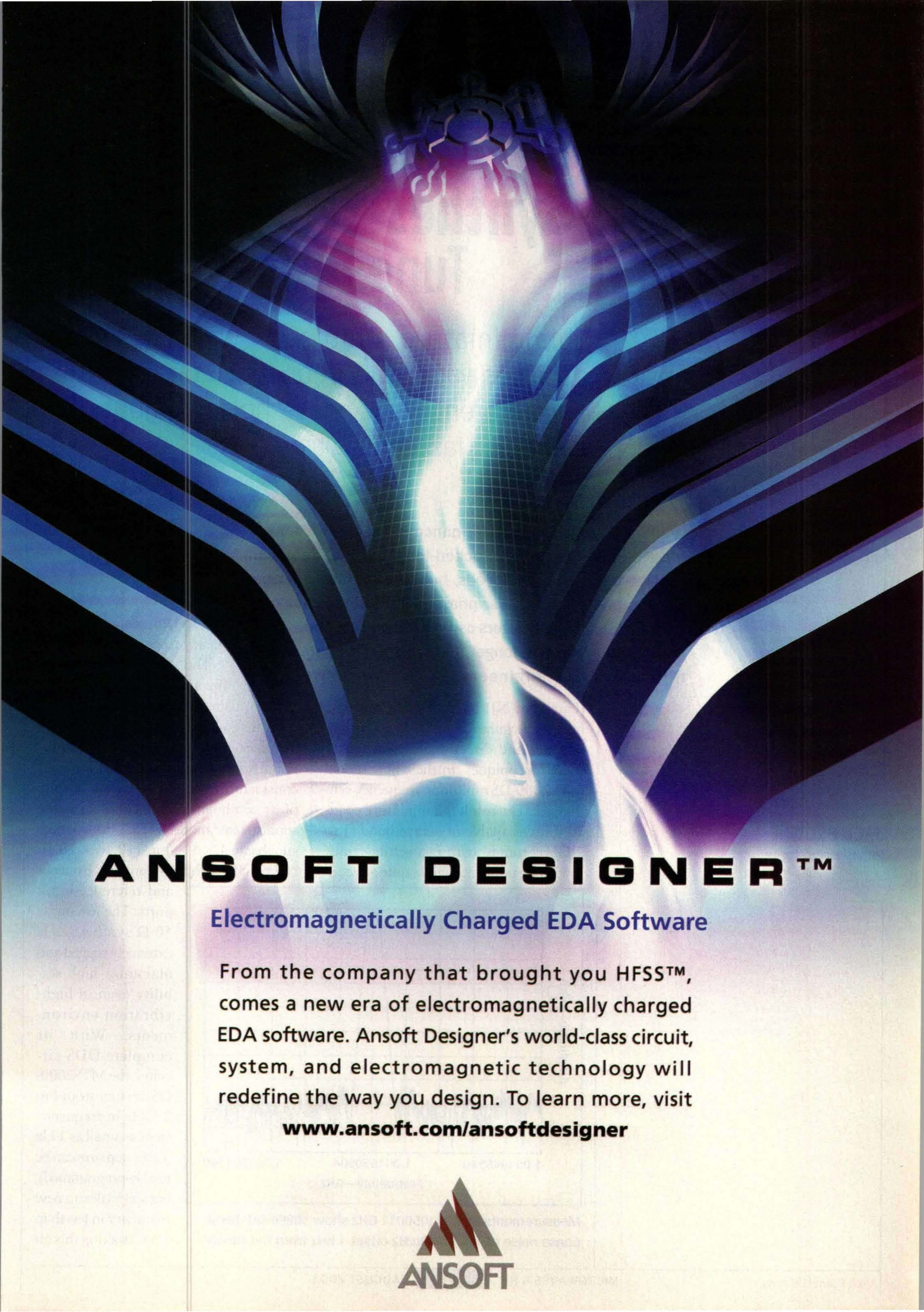
The model AR3987-1 Microwave Path Simulator can duplication propagation losses in transmission paths from 10.70 to 13.25 GHz.

frequency (IF) substitution techniques at fixed frequencies, with attenuation measurements made incrementally from 0 to 10 dB, then 10 to 20 dB, then 20 to 30 dB, and so on until the highest attenuation setting.

The cumulative frequency response of the AR3972-1 Microwave Path Simulator is better than 0.5 dB for narrowband (50 MHz or less) applications and less than 2 dB from 10.70 to 13.25 GHz. The level balance between various output ports is better than 2 dB. Isolation between adjacent ports is at least 25 dB (from port B to port C and from port B′ to port C′) and as much as 28 dB or more (from port A to port B and from port A′ to port B′).

Since the AR3987-1 is a passive system, the couplers, attenuators, connectors, and transmission lines exhibit some insertion loss even when all attenuators are set to zero. For example, the through-path losses from port A to A′ or from A to B′ is less than 38 dB, while the worst-case through-path losses, from port B to A′, B′, or C′ or from port C to A′, B′, or C′, is less than 46 dB.

The model AR3987-1 Microwave Path Simulator is designed for use with additional test equipment and hardware, including a scalar network analyzer, signal generator, a set of attenuators, adapters, and a VSWR bridge. The company verifies performance of its simulators **(see table)** over temperatures from +32 to +125°C. **ARRA, Inc., 15 Harold Court, Bay Shore, NY 11706; (631) 231-8400, FAX: (631) 434-1116, e-mail: sales@arra.com, Internet: www.arra.com.**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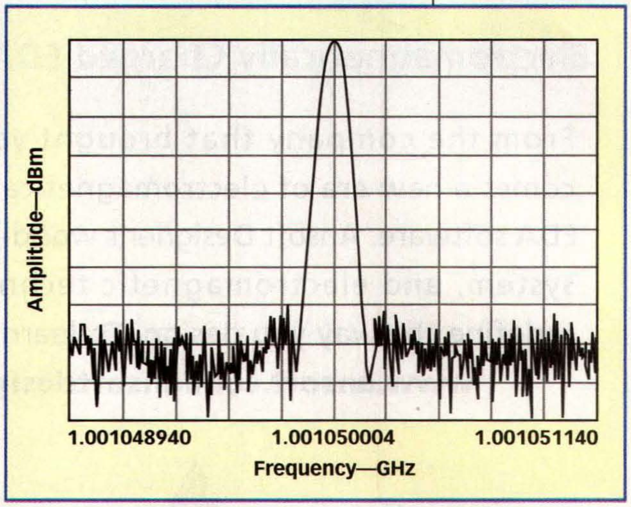
Multiloop Synthesizer Tunes 1 To 2 GHz

This miniature multiloop synthesizer achieves wideband frequency coverage and reference-like phase noise without sacrificing fast settling time.

JACK BROWNE
Publisher/Editor

Frequency-synthesizer performance is usually a compromise. Single-loop phase-locked-loop (PLL) designs can achieve fast switching speeds, but lack the filtering capability to dramatically lower phase noise and spurious content. Multiloop synthesizers can cut the noise, although the multiple loops require longer frequency settling times. Significantly, the engineers at Synergy Microwave (Paterson, NJ) have blended multiple frequency-synthesizer technologies, including PLL and direct-digital synthesizer (DDS) techniques, in their new model MTS2000-DS multiloop frequency synthesizer. The result is a miniature coaxial source capable of octave-band (1 to 2 GHz) tuning with fast settling time, low phase noise, negligible spurious content, and impressive 1-Hz frequency resolution.

The MTS2000-DS employs mix-and-divide frequency generation, using PLL filtering to reduce spurious content. The synthesizer offers the phase-noise performance of a traditional fractional-N synthesizer, but with considerably wider bandwidth. In spite of its combination of technologies, the sophisticated model MTS2000-DS measures only 4 × 4 × 1 in. (10.16 × 10.16 × 2.54 cm) with SMA female RF output and reference input ports. The low-mass 50-Ω synthesizer is extremely rugged and maintains high stability even in high-vibration environments. With its complete DDS circuitry, the MTS2000-DS can tune from 1 to 2 GHz in frequency steps as small as 1 Hz (other step sizes can be readily programmed), but still settle to a new frequency in less than 2 ms, making this an



Measurements at 1.001050011 GHz show single-sideband phase noise of –94.97 dBc/Hz offset 1 kHz from the carrier.

ideal "building-block" source for built-in-test-equipment (BITE) systems and dedicated test instruments.

The MTS2000-DS frequency synthesizer delivers nominal output power of +3 dBm. It maintains relatively flat output power of ±3 dB over a wide temperature range of –20 to +70°C. The spurious content is surprisingly low for a DDS-based source (thanks to the multi-loop configuration), at an almost negligible –65 dBc.

While its wide tuning range equips the MTS2000-DS for a variety of applications, its outstanding phase noise supports additional uses including by means of frequency multiplication for higher-frequency signals. The phase noise for the MTS2000-DS is based on a stable reference source with phase noise of –140 dBc/Hz. Near the noise floor (an offset of 1 MHz from a 1-GHz carrier), the phase noise approaches that reference level, at –135 dBc/Hz. Closer to the carrier, the specified phase noise is –90 dBc/Hz offset 100 Hz from a 1-GHz carrier, –95 dBc/Hz offset 1 kHz from a 1-GHz carrier, –95 dBc/Hz offset 10 kHz from a 1-GHz carrier, and –110 dBc/Hz offset 100 kHz from a 1-GHz carrier.

Measurements conducted with a high-performance spectrum analyzer from Rohde & Schwarz (Munich, Germany) back these published claims. With the reference level set at +3 dBm, the spectrum analyzer reveals single-sideband (SSB) phase noise of –94.97 dBc/Hz offset 1 kHz from the carrier. The measurement was performed with the analyzer's center frequency tuned to 1.001050004 GHz and a span of 2.2 kHz, the resolution bandwidth set to 50 Hz, and the video bandwidth set to 100 Hz **(see figure)**. Additional measurements on the spectrum analyzer revealed phase noise of –95.41 dBc/Hz offset 10 kHz from the carrier, and –108.51 dBc/Hz offset 100 kHz from the carrier.

Standard MTS2000-DS models are shipped with an integral frequency multiplier for use with an external reference oscillator (a 10-MHz oscillator capable of +10 dBm power). For custom reference frequencies, contact the factory. Although the initial design covers 1 to 2 GHz, the architecture is fullable scalable to cover other frequency ranges. The MTS2000-DS employs a D-type connector at its data port, and a simple three-wire programming interface. The frequency synthesizer operates with bias supplies of typically 350 mA at +5 VDC and typically 50 mA at +20 VDC. P&A: $1795.00 (small qty.); stock. **Synergy Microwave Corp., 201 McLean Blvd., Paterson, NJ 07504; (973) 881-8800, FAX: (973) 881-8361, e-mail: sales@synergymwave.com, Internet: www.synergymwave.com.**

Free Software Is Powerful Simulator

The student version of a popular simulation software suite provides a comprehensive array of linear-circuit and system-simulation capabilities, and is free of charge.

DAVID VYE
Product Marketing Manager, Ansoft Design
Ansoft Corp., Four Station Square, Pittsburgh, PA 15219-1119; (412) 261-3200, FAX: (412) 471-9427, Internet: www.ansoft.com.

Simulation can be expensive, especially when adding essential function modules to a suite of programs. But for those hoping to perform some basic linear circuit and system simulations, cost need not be an issue, especially when considering Ansoft Designer SV (Student Version) software from Ansoft Corp. (Pittsburgh, PA). The suite of linear-simulation tools provides a long list of capabilities, from a complete set of linear-component electrical models to filter synthesis and physics-based distributed models, all encompassed in a modern integrated design suite—and it's free.

Ansoft Designer SV features the same desktop design environment utilized by the company's commercially available high-frequency electronic-design software, Ansoft Designer and Version 9 of the electromagnetic (EM) simulator High-Frequency Structure Simulator (HFSS). The environment includes fully integrated schematic and layout editors, dynamic project and solution managers, advanced results graphing, post-processing, a three-dimensional (3D) viewer, and a scripted and parameterized footprint editor. The state-of-the-art solver technology includes a complete linear-circuit simulator, a complete set of physics-based linear distributed transmission-line models, discontinuities, commercial components, and ideal circuit elements. Circuit-simulation results includes S, Y, and Z parameters, VSWR, insertion and return loss, gain, stability circles, noise figure, and group delay.

The integrated schematic capture and layout editors in Ansoft Designer SV operate on a single database, which allows physical and symbol views of a design to be fully synchronized, and designers can work from either view. A change made to any component parameter is applied to the component and automatically updated in both views. This makes it possible to get a real-time understanding of a circuit's electrical performance and physical layout.

Ansoft Designer SV also provides a full set of transmission-line models and a utility to characterize them before placement into a circuit or system. Transmission lines and couplers can be analyzed and synthesized in seconds using the integrated transmission-line (TRL) utility. By entering the electrical properties, the tool will automatically synthesize the physical description or vice versa. The TRL utility includes microstrip, stripline, and coplanar waveguide mediums.

Like its commercially available version, Ansoft Designer SV offers a very large set of distributed models for com-

mon and obscure geometries required for RF and microwave circuit design. Mediums include microstrip, stripline, coplanar waveguide, grounded coplanar waveguide, and coaxial cables. The physics-based models perform over wider frequency ranges making them ideally suited for millimeter-wave applications. The software also uses Ansoft's approach to discontinuity modeling, which is derived from a solvable electromagnetic problem. In doing so, greater accuracy is assured.

The most accurate approach to characterizing full-wave, uniform, coupled transmission lines is by the spectral-domain method employed by Ansoft Designer SV. This method is fast and accurate and boasts a wider range of applications than other methods.

The result is that Ansoft Designer and Ansoft Designer SV's multiple coupled-line model has become a workhorse in the analysis of interdigital microwave filters, coupled "hairpin" filters, edge-coupled filters, combline filters, and interdigital capacitors. The algorithm allows the distributed component model to provide a highly accurate characterization of up to 20 parallel transmission lines constructed in microstrip, stripline, and suspended stripline mediums. The technique accounts for the coupling that occurs between adjacent and non-adjacent lines for any arbitrary line widths and spacing and has been expanded to include lines on up to five different substrate layers.

The component library in Ansoft Designer SV contains more than 80,000 discrete linear and nonlinear surface-mount components based on manufacturer-supplied model data. Models can be added to this library by importing from vendors or by creating them using Ansoft's internal model development toolkit. All vendor parts include model data and symbol representation as well as package footprint data for direct layout implementation and floor planning. The component libraries are easily expanded by utilizing the component/library manager interface.

Ansoft Designer and Ansoft Designer SV's neutral model format (NMF) supports truth-table modeling and parametric S-parameters and links these tools to parametric results provided by HFSS. Ansoft Designer and Ansoft Designer SV can read and write industry-standard formats, such as the SnP or FLP formats. The linear table-based data addresses the need for transferability of linear network data, which can be arbitrarily parameterized, such as physical and material parameters. These formats offer multi-port network data (S-, Y-, Z-parameters, etc.) as a function of frequency. Supporting these formats allows HFSS or third-party tools to generate model data that can be incorporated into an Ansoft Designer SV simulation.

Ansoft Designer SV offers a very large set of distributed models for common and obscure geometries required for RF and microwave circuit design.

Ansoft Designer SV also includes the most powerful tool available for matching and network extraction. Through a Smith Chart tool called "Smith Tool," an exact match can be created and exported directly into the schematic. The tool plots critical design information, such as stability, gain, and noise circles, and then lets the user select ideal lumped and distributed components to interactively design an impedance transformation network that can be directly inserted into a hierarchical design. The Smith Tool works directly with the load-pull-analysis feature that enables matching networks based on large-signal circuit behavior to be created.

Physical layout also is available and lets the user draw patterns composed of simple geometric shapes, such as rectangles, polygons, circles, and arcs that can be placed on the circuit board or IC. Components in the design often consist of groups of basic shapes, called "footprints," which are the "stamp" of the component on one or more board/IC layers. If the footprint depends on component parameters such as transistor width, then it is a "parameterized footprint," which requires a capability beyond simple scaling to describe it. Ansoft Designer SV's layout tool eliminates the need for a user to program in C to manipulate footprint information. The tool embraces a standard interpretive language (Visual Basic® script or JavaScript®) and allows the script to be developed directly in the CAD environment so that changes can immediately be tested without any compilation or program restart.

Ansoft Designer SV is free of charge and available for download at www.ansoft.com/ansoftdesignersv. The program runs on a personal computer (PC) with the Windows 2000 or Windows XP operating system. **Ansoft Corp., Four Station Square, Pittsburgh, PA 15219-1119; (412) 261-3200, FAX: (412) 471-9427, Internet: www.ansoft.com.**

Amplifier Suits Wireless-Infrastructure Applications

THE RF3305 HIGH LINEARITY amplifier is designed to meet industry-specific reliability and thermal requirements to exceed life tests of wireless-infrastructure applications. The device is packaged in a 3 × 3-mm QFN package, which is footprint compatible with standard SOT-89 packages and is competitively priced with other SOT-89 offerings. As a pre-driver for the transmit chain, the RF3305 is suitable for use in CDMA and WCDMA applications which require high linearity and low noise figure over a wide dynamic range of 300 to 3000 MHz. The RF3305 operates from a single 5.0-V power supply with a 40 dBm output IP3. The amplifier exhibits 12.5 gain, 23 dBm output power, and 3 dB noise figure with an operating current range of 150 mA. The RF3305 features an 88°C/W Theta JC and a mean time to failure of 542 years. P&A: $2.48 (10,000 qty.); production quantities are available in tape and reel format at 2500 pc/reel.

RF Micro Devices, 7628 Thorndike Rd., Greensboro, NC 27409-9421; (336) 664-1233, FAX: (336) 931-7454, Internet: www.rfmd.com.

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W.L. Gore & Associates, Inc., 402 Vieve's Way, Elkton, MD 21922; (800) 445-4673, Internet: www.gore.com/electronics.

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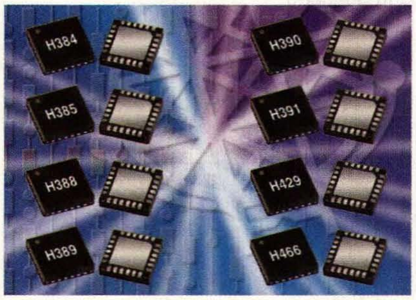
A SERIES OF SUITES for high-frequency 3D planar electromagnetic (EM) analysis features conformal meshing. Conformal meshing allows the efficient meshing of arbitrary curving transmission-line structures. The large curving subsections inherently include the natural high edge current, thus maintaining full numerical accuracy. Circuits which were previously completely impossible to analyze using any EM tool can now be analyzed in minutes and with high accuracy. Sonnet version 9 also includes other new features, such as automated generation of thick metal, automatic documentation generation, and equations.

Sonnet Software, Inc., 100 Elwood Davis Rd., North Syracuse, NY 13212; (315) 453-3096, FAX: (315) 451-1694, e-mail: info@sonnetsoftware.com, Internet: www.sonnetsoftware.com.

MMIC VCO Line Now Covers 2 To 15 GHz

EIGHT NEW MMIC voltage-controlled oscillators (VCOs) cover wireless infrastructure, test equipment, microwave radio, and military applications between 2 and 6.8 GHz. The MMIC VCOs are fabricated on a production-qualified process and integrate the resonator structure, negative resistance circuitry, tuning varactor, and output buffer amplifier, thus requiring no external components. P&A: Available from stock for sampling or sale.



Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01824; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.

PA Module Is Released For GSM/GPRS Cell Phones

THE ADL5552 IS A mobile handset power-amplifier (PA) module with integrated RF power control and measurement. The ADL5552 is the second product in the X-PA family of PA modules. The X-PA architecture uses logarithmic detection to provide precise exponential (linear-in-dB) output power control over a range of 40 dB. P&A: \$3.00 (10,000 qty.).

Analog Devices, Inc., 804 Woburn St., Wilmington, MA 01887; (800) ANALOGD, FAX: (781) 937-1021, e-mail: Customer.service@analog.com, Internet: www.analog.com.

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Resp. for design & development of GaAs MMIC Amplifiers using GaAs HBT & other processes for 900 MHz to 5 GHz commercial wireless applications. Will design power amplifiers & other circuits based on GaAs HBT & other processes utilizing CAD tools employing large & small signal models. Will evaluate existing process capabilities for various GaAs MMIC designs, specifically GSM & WCDMA power amplifiers; dev. new MMIC designs based on prototype & experimental processes; work w/ test engineers on MMIC characterization & verify circuit & design performance to ensure reliability & manufacturability. Must have Master's degree in electrical eng. w/ a concentration in RF design or electromagnetic theory plus 1 yr. exp. in job offered or 1 yr. exp. as electrical eng. designing GaAs MMIC's. Exp. must include: 1) designing power amplifier modules for GSM & WCDMA applications; 2) working w/ GaAs or SiGe processes using HBT technology; 3) design tools incl ADS, AWR & PSpice. Must have unrestricted authorization to work in U.S. M-F, 9-5. 40 hrs/wk. Salary: $84,500-$89,000/yr. An EOE. Send 2 copies of resume to Case No. 200201714, Labor Exchange Office, 19 Staniford St., 1st Fl., Boston, MA 02114.

To **place your classified ad** in Microwaves & RF's Engineering Careers, please contact:

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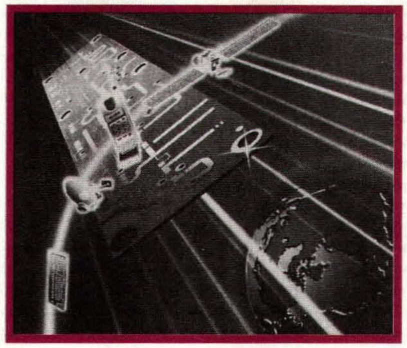
TECHNOLOGY MEDIA

looking back



ONE DECADE AGO, a line of low-cost flexible circuit board materials were developed by Arlon (Bear, DE) in anticipation of growing markets for high-frequency analog and high-speed digital circuits.

next month

Microwaves & RF September Editorial Preview

Issue Theme: Military Electronics

News

Military Electronics represents one of the fastest-growing segments of high-frequency electronics, and the Third Annual Military Electronics Show (MES) will offer a snapshot of this important business area. September will provide the highlights of the MES technical conference for those who can't attend the show (Baltimore Convention Center, September 16-17, 2003), summarizing presentations on network security, analog optical links in military systems, modeling components for military systems, measurement strategies, high-power semiconductors for next-generation military transmitters and more. Also in this issue, don't miss an inside look at the Smiths companies, numerous high-frequency manufacturers (including Florida RF Labs) that make up part of a giant British-based avionics contractor.

Design Features

September's Design Features will support the issue theme with one author's experience at specifying and using high-performance coaxial cables in military electronics systems. Also in September, a special report explains how high-power LDMOS transistors can be modified for improved efficiency and linearity. Additional articles include an overview of antenna design requirements for the Satellite Digital Audio Radio System (SDARS), and a semiregular author from Rockwell Collins will detail the design of an electrically tunable L-band preselector with a combline suspended-stripline bandpass filter and microstrip LNA.

Product Technology

September explores a new line of oscillators promising unrivaled spectral purity in tiny chip-scale packages. Suitable for both commercial and military systems, these ultraclean sources provide the low phase noise needed for phase-based modulation systems. In addition, September will review a set of educational courses on CD-ROMs from Eagleware, including courses on lumped-element transforms, the meaning of Q (quality factor), and how to design filters using transmission zeros. Also, September will highlight a new signal analyzer with 25-MHz modulation-bandwidth capability, a line of frequency synthesizers with microsecond switching speed to 40 GHz, and a versatile software simulation/analysis package dedicated to baseband circuitry.

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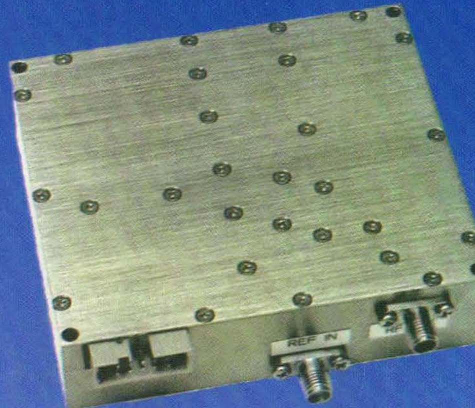

Phase Noise SSB typical (dBc/Hz)	1.5-2 GHz	4.4-6 GHz	8.6-11.6 GHz
100 Hz	-89	-79	-73
1 kHz	-111	-101	-95
10 kHz	-115	-105	-99
100 kHz	-120	-110	-104
1 MHz	-140	-130	-124

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